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Central Eurasia

Military Affairs

Armaments, Politics, Conversion

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[The following are translations of selected articles from VOORUZHENIYE, POLITIKA, KONVERSIYA published in Moscow by the Scientific Research Institute for Systematic Analysis of Problems.]

Editor's Column

95UM0191A Moscow VOORUZHENIYE, POLITIKA, KONVERSIYA in Russian No 2 (5), 1994 (signed to press 27 Oct 94) p 1

[Editorial by V. V. Panov]

[FBIS Translated Text] An analysis of the directions of research and financing of experimental development work and the production of military equipment and gear shows that various countries are giving more and more attention to upgrading servicemen's personal gear and equipment (individual gear). Below we will take personal gear and equipment to mean the sum total of a soldier's armament as well as means for his protection, life support, survivability and viability, and auxiliary gear supporting combat activity under various conditions.

The importance of modern personal gear and equipment has grown substantially with the decreased likelihood of mass destruction weapons being employed and with armies' constant reorientation toward preparing for operations in local conflicts, where there is a sharp rise in the role of a serviceman operating separately under field conditions. Contributing to this trend is the rapid development of powerful weapons, including nontraditional weapons, which may be employed by the individual serviceman in combination with effective means of individual protection. Their level of development gives rise to new requirements, and advanced technologies contribute to rapid improvement of individual means of protection, weapons, as well as means of orienting oneself on the terrain, communicating, detecting the enemy, aiming and so on. Finally, professionalization of armies presents ever broader requirements for all components of servicemen's life support, both when conducting combat operations as well as in peacetime.

All this gives rise to the problem of the serviceman's future personal gear and equipment as an aggregate of difficult scientific-technical and organizational tasks demanding large financial outlays for their fulfillment and which can be accomplished only within the scope of special state programs. Many countries have realized the need for a comprehensive approach to creating the 21st century serviceman's personal gear and equipment which ensures successful conduct of battle, which meets ergonomic and medical-biological requirements and which is created with consideration of the capabilities of advanced technologies (the U.S. Soldier Modernization Program, SMP, serves as an example). We are seeing an attempt to design personal gear and equipment on a modular principle with a high level of standardization and to provide outfitting for servicemen of different specialties and workers of special services and forces, including those employed in various extreme situations. The personal gear and equipment must be open and allow additional components to be included.

An important element is the creation of basic sets on whose basis specialized personal gear and equipment can be created for personnel to perform a wide range of tasks.

The success of future combat operations depends largely on how successfully the achievements of natural and engineering sciences and advanced technologies are embodied in personal gear and equipment and how successfully the gear has been made to conform to tactics of combat operations. The attitude toward small arms, for example, is characteristic for revealing contradictions. Here the dominant trends toward reduced caliber, increased accuracy and grouping, and increased rate of fire of weapons have been replaced by a priority requirement for increasing the energy of submunitions necessary to kill personnel equipped with modern means of individual protection.

In contrast to many other directions of military affairs, exploratory research and the work of designing elements of servicemen's personal gear and equipment also have a humanitarian direction. This is because they respond to national values and values common to all mankind, since they contribute to improved outfitting and increased effectiveness of operations by agencies for protection of order, by subunits assigned to fight natural disasters, and by other persons working under conditions of increased risk.

GEOPOLITICS AND SECURITY

Military-Technical Problems of National Security

95UM0191B Moscow VOORUZHENIYE, POLITIKA, KONVERSIYA in Russian No 2 (5), 1994 (signed to press 27 Oct 94) pp 4-7

[Interview with General of the Army Yuriy Alekseyevich Yashin, chairman of State Technical Commission under the Russian Federation President, doctor of technical sciences, professor, State Prize laureate, vice president of Russian Engineering Academy, by VOORUZHENIYE, POLITIKA, KONVERSIYA, date, place and occasion not specified; photograph of Yashin included]

[FBIS Translated Text] *Yuriy Alekseyevich Yashin completed the command and engineering faculty of the Military Academy imeni F. E. Dzerzhinskiy and the General Staff Military Academy; he is a specialist in the field of rocket building and information science. He is a doctor of technical sciences, professor, State Prize laureate, and author of over 50 scientific works. He is vice president of the Russian Engineering Academy, and at a general meeting of the Russian Engineering Academy in May 1994 he was elected head of the newly established military-technical direction.*

General of the Army Yashin presently is chairman of the State Technical Commission under the Russian Federation President.

[VPK] Yuriy Alekseyevich, it is obvious that military-technical problems are among the most important aspects of national security. What contribution does the Russian Engineering Academy intend to make to resolving them?

[Yashin] The fundamental changes in the international situation and in the country's internal life occurring before our eyes require a revision of approaches previously used to ensure national security. This is a fully natural and positive process, but it is unfolding in the specific situation of modern-day Russia and its possible results produce substantiated fears.

Let us take a chief element in ensuring national security—preserving sufficient military might of our country. In the absence of military doctrine and precise military reform programs the "avalanching conversion" which began in the 1980's led the Russian military-technical and intellectual potential of the defense complex to the brink of disaster.

At the same time, the overall economic situation remains extremely complex: we cannot expect a "golden rain" of state appropriations for the military-industrial complex.

Following from this is an objective need to seek nontraditional solutions. In particular, a need has arisen to create a nonstate scientific structure. By bringing together scientists, engineers, enterprise heads and representatives of government establishments in its makeup, such a structure could make an important contribution to coordinating the work of long-range forecasting and creation of armament and military equipment; to seeking the most effective ways of using resources allocated to the Ministry of Defense for creating new models and for scientific research; to identifying priority directions of weapon development; to managing conversion and planning its state support; and to coming up with a comprehensive approach to using Russian Armed Forces resources in the civilian sphere. These functions could be fulfilled by the Russian Engineering Academy, which has sufficient potential for this.

Considering the great importance of defense problems, in May 1994 the Academy's General Assembly established a military-technical direction consisting of three sections: Aerospace, Military-Technical Problems, and Engineering Problems of Stability and Conversion.

The Aerospace Section is headed by Academician-Secretary G. Ye. Lozino-Lozinskiy, well-known General Designer of aircraft and space systems. The section's collective members are the Energiya NPO [Scientific-Production Association], TsAGI [Central Aero-Hydrodynamics Institute], NII [Scientific Research Institute] of Aviation Technology, LII [Flight Research Institute] imeni Gromov, TsIAM [Central Institute of Aircraft Engine Construction] and a number of other authoritative scientific-technical centers.

Academician-Secretary V. V. Panov, one of our most prominent specialists in the field of conceptual questions of creating armament and military equipment, is chairman of the Military-Technical Problems Section. The makeup of collective members includes Goskomoboronprom [Russian Federal Committee on the Defense Industry], Expert Council under the Russian Federation Government, Russian Academy of Sciences Applied Problems Section, Polet NPO, Raduga MKB [Machinebuilding Design Bureau], NII imeni Chaplygin, Tveruniversalbank, and scientific establishments and academies of the Ministry of Defense and FSK [Federal Counterintelligence Service].

Academician-Secretary L. I. Volkov, a recognized authority in the field of military-technical research and development, directs the Engineering Problems of Stability and Conversion Section. Collective members of the section are the Moscow Institute of Heat Engineering and Russian Ministry of Defense scientific research institutes.

Directions of scientific-technical activity of the sections have been specified:

- Aerospace Section: prospects for aviation technology, reusable space transportation systems, aerospace means of insertion, satellite systems and orbital space stations, conversion and space technologies, use of outer space for mankind's needs, and expert examination of advanced developments;
- Military-Technical Problems Section: scientific research and development in the military-technical sphere, assistance in their investment, scientific-technical conferences, expert examination, publishing activity, and establishment of certification centers;
- Engineering Problems of Stability and Conversion Section: conceptual questions of strategic stability and conversion, prospects for strategic arms development, information security, new science-intensive technologies (including dual-purpose technologies and intelligent systems technologies), and ecologically clean technologies for recycling and eliminating armament and military equipment.

The diagram shows the spheres of basic and applied research.

In concluding the response to your question, I would like to stress one fundamentally important point: establishment of a military-technical direction is not evidence of militarization of the Russian Engineering Academy, but a manifestation of the social responsibility of Russian scientists for processes of ensuring the country's national security.

[VPK] One of the sorest questions connected with national security is conversion. Many believe Russia is conducting it in an ill-considered manner, it is being accompanied by the creation of unnecessary difficulties and so on. What is your attitude toward conversion, viewed from a national security standpoint?

[Yashin] At the beginning of last year INZHENERNAYA GAZETA printed my article entitled "Conversion: Apparitions and Realities." Unfortunately, no fundamental changes for the better have occurred to this day.

Wide-scale conversion measures were carried out in our country during 1945-1946 and 1955-1956. At that time the planned conduct and financing of conversion was supported and a positive result was obtained.

Now conversion is being accomplished not only here, but also in essentially all leading world countries, but rates of conversion abroad cannot be compared with ours. While the reduction in military budgets there is limited to single percentage points a year, for us it is 30-40 percent. The present conversion in our country is taking place under conditions of a fundamental change in the economic model, which is occurring against the background of a colossal production decline as a result of the break of economic ties which existed in the Soviet Union's unified economic space.

The decline reached catastrophic dimensions in the defense complex and is not being compensated by a rise in civilian production. Not just objective causes, but also

MILITARY-TECHNICAL DIRECTION

SECTIONS

AEROSPACE

Areas of Basic Research

- Analysis of directions of development of subsonic & hypersonic aircraft and development of recommendations.
- Analysis & comparison of different reusable systems for insertion, & development of recommendations.
- Analysis of prospective payloads & development of recommendations.
- R&D of advanced control systems.
- Development of hypersonic flows theory.
- Development & introduction of new materials, (including "intelligent" composite materials).
- Medical-biological problems of space flights.

Directions of Applied Research

- Developing advanced civilian aircraft and aircraft cargo systems.
- Creating highly effective and ecological aircraft engines (including high-thrust engines).
- Creating the MAKS [not further expanded, possibly reusable aerospace system] system.
- Creating a suborbital demonstrator aircraft.
- Developing and creating triplanes, benches and centrifuges.
- Developing systems for getting out of emergency situations when inserting space transportation systems into satellite orbit.
- Developing technologies of highly sensitive tests of spacecraft for airtightness without use of pressure chambers.

MILITARY - TECHNICAL PROBLEMS

Areas of Basic Research

- Forecasting main directions of development of means of warfare (nontraditional and based on new physical principles and on dual-purpose technologies) in continental and sea theaters of military operations.
- Determining priorities in development of sophisticated military-technical, military-economic and military-ecologic systems and of VVT [armament and military equipment] assets.
- Substantiating directions of military-technical policy. Forming financial and investment programs for development of VVT.
- Problems of discovery and localization of emergency situations, development & use of technical & military equipment for mopping up in the aftermath of emergency situations.
- Developing methodological & organizational foundations for managing the development & creation of VVT.
- Military-ecologic problems.
- Problems of geoinformation science & support of information security.

Directions of Applied Research

- Creating VVT, including special-purpose VVT, its military-economic assessment, and S&T accompaniment of development, production and operation.
- Developing military-economic recommendations for conversion of the defense complex.
- Substantiating export policy proposals.
- Scientific-methods accompaniment of special federal programs.
- Forming legal foundations for patenting domestic developments.
- Developing means of protecting information.
- Developing and implementing advanced technologies.

ENGINEERING PROBLEMS OF STABILITY & CONVERSION

Areas of Basic Research

- Creating a set of mathematical models for studying problems of strategic stability.
- Determining directions for improving combat capabilities of a branch of Armed Forces through use of space information support systems and equipment.
- Developing methods to simulate processes of substantiating, developing and managing weapons systems using neurocomputers.
- Determining principles of economic support to the development and production of VVT under conditions of transition to a market economy.
- Creating a concept of using space equipment for performing ecologic monitoring tasks.

Directions of Applied Research

- Developing recommendations on alert-status regimes of missile systems for conditions of a reduction in the level of strategic nuclear parity.
- Developing measures ensuring concealment of installations against space and aerial reconnaissance assets.
- Developing proposals for using booster rockets in support of the Ministry of Defense and for national economic purposes.
- Developing proposals for dual technologies to support the creation of Ground Troops' systems and civilian products.
- Developing a system for safe elimination of RDTT [solid-propellant rocket engines].

subjective factors linked with the activity of specific people are at fault for this. A large number of enterprises have been cast to the whim of fate and are operating according to the principle of "Every man for himself!" All this exacerbates the already painful conversion process and naturally has a negative effect on national security.

Just what should be done now? I will express an opinion which formed as a result of much work by the Russian Engineering Academy in the conversion sphere. First of all it must be realized that the bulk of world-level domestic high technologies historically has been concentrated in the military-industrial complex. Its disintegration not only will have a negative effect on our national security, but also will destroy a source for replenishing the civilian sector with advanced technologies, i.e., it will have a negative effect on our economy's overall prospects.

Further, we must firmly determine our position with respect to the state order for defense. Its conformity to requirements of defense sufficiency and its normal budget financing must be ensured. Enterprises must know at least the immediate prospects of their utilization for military products and time periods for receiving appropriations. Without this they cannot form their own industrial-engineering policy.

Meanwhile, already now there are a number of examples of successful redistribution of enterprise resources between civilian and military production and of the determination of appropriate forms of organization of industry. Thus, enterprises which united in the Kompleks Scientific-Technical Center worked out the Start-1 commercial missile-space system, whose solid-propellant rocket is capable of inserting a payload weighing up to 500 kg into a near-Earth orbit 700 km high.

Practically all enterprises connected with the production and development of Sukhoy aircraft as well as a number of commercial banks became part of the Sukhoy unified industrial-financial group, which is capable of achieving necessary production stability in the present difficult situation.

Further, those elements of military production which can be transferred to "new soil" essentially instantaneously must be introduced to civilian production with maximum speed (for example, advanced structural materials, including composites).

Real provision of state support to foremost scientific-production centers being converted remains a very important problem. The Russian Federation Presidential Edict of 22 June 1993 "On Russian Federation State Scientific Centers," which provides for giving special state support to leading scientific centers, including centers of the defense complex, has a more positive significance in this regard. The support must be accomplished in particular by providing priority financing to these centers via the Russian Ministry of Science and Technology Policy and by capital investments through the Russian Ministry of Economics. Unfortunately, the absence of direct budget financing of state scientific centers under conditions of spasmodic and insufficient allocation of funds for the needs, for example, of the Ministry of Science and Technology Policy, leads for now only to minimal advantages of the centers compared with the rest of the scientific organizations. True, the adoption of Russian Federation Government Decrees Nos 648 and 649 of 5 June 1994 "On Implementation of the Russian Federation Presidential Edict of 22 June 1993 On Russian Federation State Scientific Centers'" gives hope for an improvement in the situation.

Considerable attention also should be given to coordinating efforts of all parties interested in success of converting the Russian defense complex. For example, the Russian Center for Conversion of the Aerospace Complex, which was established in accordance with recommendations of the "Aerospace Complex Conversion" International Conference ("Moscow Declaration of 1992") and which unites leading sector enterprises, commercial structures and public organizations, is attempting to perform that task.

[VPK] Are conversion problems exhausted by its economic and technical aspects?

[Yashin] Of course not. Conversion of the defense complex is an exceptionally complicated, multiple-factor process. Suffice it to mention the acute social questions of conversion, cadre problems and so on.

The information aspect of conversion, for example, deserves special attention. Its meaning lies in the fact that, first of all, information which previously was undividedly and rigidly controlled by the state is beginning to circulate within an enormously broader circle of users (this is especially characteristic of dual-purpose technologies); secondly, organizations and enterprises of the military-industrial complex are turning into points of intersection of information systems operating simultaneously both with unclassified as well as classified information; thirdly, completely new information property problems are arising.

An unsanctioned distribution of technologies of mass destruction weapons, extremely attractive to various ambitious regimes and terrorist groupings, can become the most dangerous consequence of underestimating the information aspect of conversion.

Much work presently is being done to provide effective protection for state, official and commercial secrets in the course of conversion. It stands to reason that the protection system being newly created must conform fully to new political, social and economic realities.

Where Will the New Russian Space Launch Facility Be?

95UM0191C Moscow VOORUZHENIYE, POLITIKA, KONVERSIYA in Russian No 2 (5), 1994 (signed to press 27 Oct 94) pp 8-11

[Article by Colonel (rank from photo) Anatoliy Ivanovich Kuzin, doctor of technical sciences, chief of a directorate of Central Scientific Research Institute of Russian Federation Ministry of Defense Military-Space Forces; photograph of Kuzin included]

[FBIS Translated Text] *Doctor of Technical Sciences Anatoliy Ivanovich Kuzin completed the Military Academy of Chemical Defense imeni S. K. Timoshenko. He is a specialist in the field of spacecraft insertion equipment and is the author of over 100 scientific works.*

Anatoliy Ivanovich presently is chief of a directorate of the Central Scientific Research Institute of Russian Federation Ministry of Defense Military-Space Forces.

The history of development of domestic cosmonautics is linked closely not only with outstanding successes of scientist-developers and flights of pilot-cosmonauts, but also with the creation of the enormous infrastructure of Russia's space sector, including above all space launch facilities. Russian military and national economic spacecraft presently are launched from two space launch facilities, Plesetsk and Baykonur. Use of the Plesetsk space launch facility is limited by its geographic position inasmuch as the energy effectiveness of using means of insertion is linked closely with the latitude of the booster rocket launch point. This is dictated by the influence of the Earth's rotation on the amount of requisite velocity which the means of insertion imparts to an object being inserted into orbit. For launches in an easterly direction, it leads to the appearance of the so-called "latitude increment" of velocity, the amount of which (V, m/sec) is V=465 cos i, where i is the geographic latitude of the launch point of the means of insertion.

Therefore all countries which have access to outer space strive to position their space launch facilities as close to the Equator as possible. Table 1 provides information on the geographic position of space launch facilities of "space club" member countries with an indication of the amount of latitude increment of characteristic velocity.

Table 1 - Characteristics of Space Launch Facilities

No	Space Launch Facility	Country	i, deg	V, m/sec
1	Baykonur	Russia	47 North	317
2	Plesetsk	Russia	63 North	212
3	Eastern	USA	29 North	409
4	Western	USA	34 North	384
5	Wallops Island	USA	38 North	369
6	Kourou	France	5 North	463
7	Uchinoura	Japan	31 North	398
8	Tanegashima	Japan	30 North	401
9	Changchengjiel	China	41 North	351
10	San Marco	Italy	3 South	464
11	Sriharikota	India	15 North	450
12	Negev	Israel	30 North	403*

*Launches from the Negev space launch facility are made in a westerly direction

An intergovernment agreement was concluded between Russia and Kazakhstan in March 1994 about leasing the world's largest spaceport of Baykonur. This envisaged a many-sided use of this complex, including commercial use and international cooperation, but there are difficulties in Russia's use of this spaceport, and ever newer ones are arising.

Therefore work now is being done to substantiate and search for the most advantageous place to site a new spaceport, and not just on Russian territory. Thus, in July 1994 there were talks by representatives of the Australian Space Transportation System company with Russian aerospace firms devoted to questions of establishing a launch complex for heavy-class Proton booster rockets on one of the islands of Papua-New Guinea.

But ballistic effectiveness is not the sole requirement which must be satisfied by the new Russian spaceport. What is important and sometimes even determining, especially with today's financial and resource limitations, is the presence of a developed material-technical base and a primary infrastructure which could be used in constructing and operating a new spaceport. Transportation arteries (highways and railroads), communications lines, energy resources and, finally, installations for social and cultural life, i.e., everything that will permit supporting the creation of a spaceport with minimal time and monetary outlays, should be included here.

If funds are put into creating a new spaceport, then of course it should be located on Russian territory. Natural and social-demographic conditions in the region where such a sophisticated complex is located are of no small importance here. The distance of the booster rocket launch site from densely populated areas of Russia should be borne in mind here above all. This is dictated exclusively by questions of safe operation of means of insertion both during their launch as well as in the boost phase of their functioning. It is also desirable to reduce to the maximum extent the number and size of land impact areas of the separating parts of booster rockets by using sea and ocean expanses primarily for this purpose. The location of the space launch facility must be seismically safe. Finally, construction of the space launch facility should be fully supported by the industrial base and human resources. As of the present time a detailed analysis has been made of alternative options for siting a new Russian space launch facility based on the aggregate of the factors examined and many others. As a result of this work, reports appeared in the pages of the press about the Amur Oblast city of

Svobodnyy-18 as the most probable spot for establishing a Russian space launch facility.

Already now it is necessary to thoroughly think out ways of solving problems which unquestionably will arise in creating a new space launch facility, and there are many such problems. Naturally, the paramount task is to determine the sequence of accommodating the means of insertion that are being created at the new space launch facility. A distinguishing feature of the eastern space launch facility is that it is planned to be established on the basis of a disbanded Strategic Missile Troops formation and consequently maximum use must be made of the selected area's potential. It is obviously legitimate to raise the question of priority development of a light class of means of insertion such as the Rokot booster rockets being developed based on strategic missiles being reduced. After a certain modification, such missiles are capable of inserting up to a 1.5 tonne payload into low, near-Earth orbits, which will permit accomplishing a large number of defense and national economic missions in outer space. Without question, a more important direction for development of the eastern space launch facility should be considered the accommodation of heavy-class boosters there; as noted earlier, this is especially advantageous from an energy standpoint.

Figs. 1 and 2 present design data describing losses of payload weight as applied to a heavy class of booster rocket launched from the Baykonur, Plesetsk and Vostochnyy [Eastern] space launch facilities.

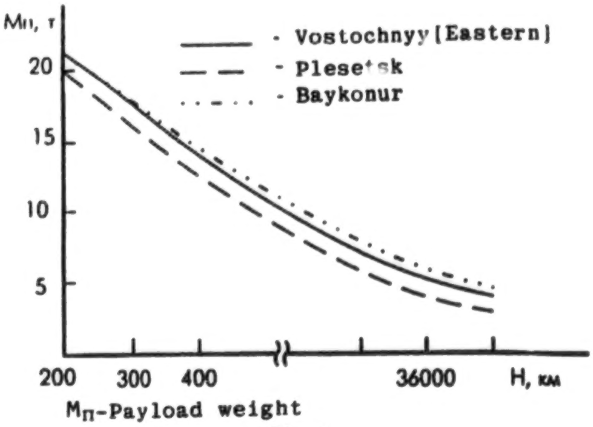

Fig. 1

An analysis of these data permits concluding that payload losses are especially significant for high-energy orbits when spacecraft are launched from the Plesetsk space launch facility. For example, these losses can reach 22-25 percent for a geostationary orbit compared with a launch from the Baykonur space launch center. In this connection there also is an obvious conclusion about the advantageous development at southern-latitude space launch facilities of heavy-class boosters capable of performing transportation missions requiring large energy outlays.

Prospects in the area of heavy-class boosters presently are linked with realization of project Angara, devoted to developing a 21st century booster capable of performing the entire set of defense and national economic missions at the borderline of the years 2000-2001, including missions requiring mastery of high-energy orbits. The development of this booster is oriented exclusively toward the Russian scientific and production base using existing experience and the scientific-technical work done in advance on the Zenit booster rocket and on the Energiya-Buran system.

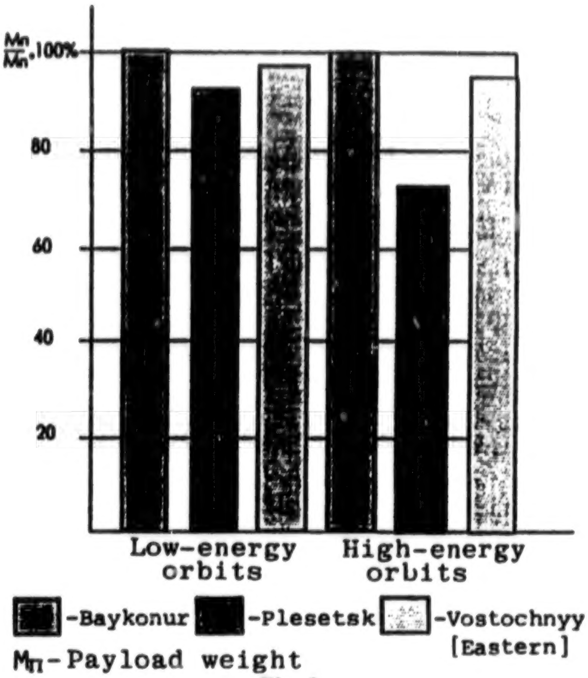

Fig. 2

A special place among problems which must be resolved in creating the eastern space launch facility belongs to questions connected with ensuring ecologic safety in operating space assets. Attention should be directed especially at the light-class Rokot booster rocket, where nitrogen tetroxide and unsymmetrical dimethylhydrazine are used as fuel components.

The effect of booster rockets on the environment can show up in essentially all basic stages of their "life cycle." When the booster rocket is being prepared for use for its specific purpose, the main source of environmental pollution can be fuel components entering the surrounding space in nonstandard situations in the course of technological operations of fueling, draining, and thermostatic control of fuel and oxidizer. In normal operation such discharges are reduced to a minimum, and in systems with toxic fuel components special measures are envisaged for recycling them in the form of steam and the liquid phase. The spectrum of factors affecting the environment is broader during a booster rocket launch and in the boost phase of insertion. Above all one must note that a certain quantity of rocket fuel combustion products enters the atmosphere. Table 2 shows the makeup of such products as applied to Kosmos and Soyuz booster rockets.

Table 2 - Composition and Quantity of Kosmos and Soyuz Booster Rocket Fuel Combustion Products

No	Type of Booster Rocket	Stage No	Quantity of Combustion Products, t					
			H_2	H_2O	CO	CO_2	N_{2t}	Others
1	Kosmos	1	0.96	25.3	8.29	20.9	24.7	0.11
		2	0.35	4.16	0.78	6.1	5.2	0.02
2	Soyuz	1	1.40	40.9	52.4	59.6	0.0	0.02
		2	1.00	23.3	32.7	34.0	0.0	0.004
		3	0.48	4.2	8.0	9.7	0.0	0.00

Rokot and Angara boosters also will have a similar composition of combustion products. It should be noted that, considering the aftercombustion of carbon monoxide in the atmospheric phase of booster rocket flight, the "exhaust gases" given off do not contain specific toxic compounds and cannot be compared at all with industrial discharges such as of metallurgical, coal-tar chemical or pulp and paper enterprises, which contain the whole gamut of toxic compounds, including phenols, polycyclic carbons, hydrogen sulfide and others. The rocket fuel combustion products that are given off are capable of affecting the atmosphere's ozone layer, leading to a local decrease in ozone concentration along the booster rocket insertion path. At the same time, it should be noted that, according to available assessments, the "ozone hole" arising during the launch of a booster rocket becomes covered over from turbulent diffusion in the course of 40-60 minutes, and the overall contribution of all booster rockets to ozone layer destruction is 10^{-4}-10^{-3} percent of the alternative consequences of anthropogenic activity.

Emergency situations present the greatest danger with use of booster rockets for their specific purpose, especially in initial stages of booster rocket flight, when booster tanks contain a considerable quantity of fuel components. As a rule, booster rocket accidents in the final account are accompanied by explosions, leading to self-destruction of the main volume of fuel components, and mopping up the aftermath of an accident can be reduced merely to neutralizing local places where fuel has fallen on the soil and to gathering up metal booster rocket fragments which formed as a result of the explosion.

In the process of operating means of insertion, a need arises for alienation of a certain amount of land for an impact area for booster rocket parts that separate during their standard functioning. In this case we are speaking of lands temporarily alienated from national economic use (for the period of launches). As a rule, these are rugged terrain sectors located on unpopulated territory. The principal factor worsening the ecologic condition of impact areas for the separating booster rocket parts is the presence in them of dispersed metal booster rocket fragments and remnants of fuel components which did not react with each other when the rocket module impacted the Earth's surface.

Those are the main factors which were analyzed in selecting a new Russian space launch facility. It should be noted that all countries having access to outer space (United States, France, China, Japan, India and others) encounter similar problems in operating means of insertion. Similar liquid fuel components are used in the booster rockets of these countries. Thus, asymmetrical dimethylhydrazine is used in powerplant units of Titan (USA) and Ariane (France) booster rockets. Moreover, the presence and use of solid-propellant boosters in the Space Shuttle, Delta, Scout and other booster rockets worsens the ecologic situation to a significant extent from the standpoint of atmospheric contamination by toxic and ozone-active solid propellant combustion products such as aluminum oxide, nitrogen oxides, chlorine compounds and others, which place them in an unfavorable position compared with domestic boosters, which do not use solid-propellant composites.

The primary task of the present stage of solving this problem is realization of measures for ecologic accompaniment of each launch of means of insertion, including searching for, gathering and recycling metal fragments of separating booster rocket parts and performing recultivation work on alienated territories. To preclude a negative effect of toxic chemical agents on the environment, it is planned to use exclusively nontoxic fuel components such as liquid oxygen, hydrocarbon fuel and liquid hydrogen in powerplant units of future means of insertion, including in the aforementioned Angara system. These compounds present no danger from the standpoint of effect on soil and atmosphere, and cryogenic components (oxygen and hydrogen) exist only in a gaseous state under operating temperatures. In this connection the problem of fuel components contaminating impact fields essentially is precluded.

It is important to note that the present stage in development of means of insertion is characterized by the desire to realize full reusability of all their elements. All industrially developed countries have conducted studies of rocket, aerospace and aircraft-space types of fully and partially reusable means. The NASP, Hermes, HOTOL, Hyperplane, Sanger, Delta-Clipper, TU-2000, MAKS and a large number of other projects can be named as an example. A characteristic feature of such means of insertion is the absence of fields of impact of separating parts. All separating elements of such means of insertion (if they exist) are supplied with means of returning to the launch point or they sink in waters of the World Ocean. In this connection, the question of impact areas can be resolved radically by orienting ourselves on a similar principle of using means of insertion.

The aforementioned and a large number of other technical measures aimed at ensuring ecologic safety of operation of means of insertion are envisaged within the scope of the Angara heavy-class booster being developed during its accommodation at the eastern space launch facility, which will permit reducing the unfavorable effect of booster rockets on the environment and on the unique natural resource potential of Amur Oblast to the maximum extent.

ARMAMENT AND MILITARY EQUIPMENT

Russian Federal Counterintelligence Service Weapons and Individual Armor Protection

95UM0191D Moscow VOORUZHENIYE, POLITIKA, KONVERSIYA in Russian No 2 (5), 1994 (signed to press 27 Oct 94) pp 12-17

[Article by Andrey Petrovich Bykov, deputy director of Russian Federation Federal Counterintelligence Service, doctor of technical sciences, Honored Inventor of RSFSR, Russian Federation State Prize laureate, and Sergey Vladimirovich Medvetskiy, chief of a subunit of the Russian Federation Federal Counterintelligence Service Technical Directorate, candidate of technical sciences, Russian Federation State Prize laureate; photographs of Bykov and Medvetskiy included]

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Sergey Vladimirovich Medvetskiy completed Moscow Higher Technical School imeni N. E. Bauman. He is a specialist in the field of special small arms and individual protective gear, a candidate of technical sciences, and a Russian Federation State Prize laureate. Since 1991 he has been chief of a subunit of the Russian Federation Federal Counterintelligence Service Technical Directorate.

An analysis of world statistics attests to the fact that in the early 1960's there began to be a progressive increase in crimes committed using explosives and homemade explosive devices and also accompanied by hostage-taking. A similar trend with a time shift of approximately 15 years unfortunately also is being observed in our country.

Back in the early 1970's specialists of state security agencies forecast this process for the next 10-15 years.

Taking into account forecast assessments and the actual development of events, decisions were made in the 1970's to establish a special subunit for freeing hostages and neutralizing terrorist and extremist actions by criminal groupings, and to establish corresponding subunits for detecting, diagnosing, evacuating and disarming nonstandard objects.

Establishing these subunits and having them attain a stable, productive level of official and combat activity required accomplishing a large number of difficult tasks, including outfitting with special weapons and technical equipment supporting realization of the operational-tactical concept.

For long years this task was a subject of extensive studies and developments conducted with the involvement of the article's authors. The following were the principal directions of this task:

- development of special weapons;
- creation of effective means of individual protection against injury by standard small arms bullets;
- development of special technical equipment and methods of diagnosis, evacuation and disarming of homemade explosive devices.

Familiar standard means, and above all army means, were used as armament, protective gear and technical equipment in the first stage of these subunits' activity. It must be said that such a practice is typical of foreign services.

But the very first work experience of these subunits showed, and past years confirmed, that the planning and organizing of such operations differ substantially from operations conducted by army subunits.

The following should be included above all among the principal differences:

- extremely diverse conditions of operations to free captured hostages and installations (residential or administrative building, air terminal, train station, bus, aircraft, helicopter and so on);
- in an assault on installations captured by terrorists, antiterrorist subunit personnel come into fire contact with the "enemy" at considerably shorter distances than do servicemen of army subunits in conducting combat operations under field conditions;
- the use by terrorist and extremist elements of homemade explosive devices representing increased danger compared with standard army munitions.

All this inevitably placed on the agenda the question of a need to develop and manufacture special weapons, means of individual armor protection and special technical equipment for outfitting corresponding subunits.

In the last two decades specialists of corresponding subunits of state security agencies together with defense scientific research institutes and design bureaus have engaged actively in developing such means.

The new system of individual "silent" weapons (more accurately, weapons with low revealing action) consisting of a pistol, sniper rifle equipped with optical and night sights, and assault rifle was created in that way. A new concept was made the basis of the system. Its essence is a rejection of the creation of silent weapons based on existing standard models and the conduct of special development of silent weapons and cartridges for them.

It should be noted that the alternative approach, specifically the creation of silent weapons based on standard models, is used widely in world practice. As a rule, its adherents explain this by the desire to develop a general-purpose sound-producing/silent weapon. But to realize low revealing action in firing the weapon, it is necessary not only to ensure a decrease in parameters of the escape of powder gases from the barrel into the atmosphere, but also to limit the bullet's muzzle velocity to a value less than the speed of sound in the atmosphere. The latter factor substantially affects the output characteristics of such a weapon, which always will be considerably less than for a

standard weapon, and it is possible to increase them only by one method—by using a substantially heavier bullet in the silent weapon.

Federal Counterintelligence Service subunits and the Central Scientific Research Institute of Precision Machinebuilding created models of silent arms as a result of realizing the concept in question.

Prototypes of the weapons and cartridges passed state tests successfully and became operational with Russian Federal Counterintelligence Service operations subunits. Subsequently, thanks to high specifications and operating characteristics, these models also became operational with special-purpose subunits of the Ministry of Defense and Ministry of Internal Affairs. Elements of the silent weapon system have been series-produced at plants of Roskomoboronprom [Russian Federation Committee on the Defense Industry] since 1989. The weapons which have been created concede nothing to standard individual weapons and to the best foreign models of automatic weapons (also including submachineguns).

In 1993 the silent weapon system consisting of the 6P28 pistol, 6P29 sniper rifle and 6P30 assault rifle were awarded the Russian Federation State Prize in the field of science and technology.

Main Characteristics of Special Small Arms Models

Model Designation, Country	Caliber (mm)	Model Weight (kg)	Model Length (mm)	Muzzle Velocity (m/sec)	Muzzle Energy (J)	Bullet Specific Energy (J/mm^2)	Range of Aimed Fire (m)
PSS pistol (item code 6P28), Russian Federation	7.62	0.70	161	200	210	4.60	50
PB pistol (item code 6P9), Russian Federation	9.00	0.95	310	285	235	3.69	50
Hi-Standard pistol, USA	5.60	1.282	330	280	102	4.14	25
Beretta Mod. 10 pistol, Italy	7.62	0.956	353	220-240	About 131	2.88	25
AS assault rifle (item code 6P30), Russian Federation	9.00	2.50	875,615*	290	710	11.16	400
AKM assault rifle with PBS [not further expanded] and US [not further expanded] cartridge, Russian Federation	7.62	3.50	980	295	540	11.08	200
L34A1 Sterling submachinegun, England	9.00	2.72	690,483*	About 295	600	9.43	200
Submachinegun:							
Ingram Mod. 10, USA	11.43	3.83	800	234	407	3.97	100
Ingram Mod. 11, USA	9.00	2.17	645	300	360	5.66	100
SVB rifle (item code 6P29), Russian Federation	9.00	2.60	894	290	730	11.47	400
Sniper rifle, Finland	7.62	4.74	1180	320	614	13.40	400

Note: *With folded stock

Means of individual armor protection are an extremely important element of the personal gear and equipment of personnel (above all antiterrorist subunits as well as explosives specialists).

Subunits of state security agencies actively took up the work of creating means of individual armor protection from the late 1970's. It was in this period that experience acquired in Afghanistan in combat operations by "snatch" groups showed the need for a fundamental distinction in the approach to creating means of individual armor protection for personnel of operations subunits compared with soldiers of conventional army subunits. The principal requirement for individual protective gear for personnel of operations subunits is a realization of the maximum possible level and area of protection. The weight requirement, one of the main ones for the army, is secondary here because of the relatively brief time of operations and substantially greater physical endurance of antiterrorist subunit personnel compared with the statistically average soldier. Basing themselves on that approach, the VNII [All-Union Scientific Research Institute] of Steel and the Aircraft Materials Institute performed a set of projects to develop means of individual armor protection for various purposes.

Main Characteristics of Protective Equipment

Article Codename, Country	Weight (kg)	Protected Area (m^2)	Type of Weapon and Minimum Range of Protection Against It	Type and Thickness of Armor (mm)
Vant general-purpose carried/worn armor shield, Russian Federation	80.0	1.57	AKM and AK74 assault rifles, 7N6 cartridge, 5 m	4 mm of steel
More bulletproof armor shield, Russian Federation	145.0	1.26	SVD [Dragunov sniper] rifle, 5 m	8 mm of steel, 6 mm of steel plus SVM fabric
Altyn 6B6S protective helmet, Russian Federation	3.3-3.5	0.15	TT [Tokarev Tula] pistol, steel-core bullet, 5 m	3 mm of titanium plus SVM fabric
Tig protective helmet, Germany	3.0	0.15	PM [9 mm Makarov] pistol	3 mm of titanium
Concealed vests:				
Vizit-M, Russian Federation	3.4-4.3	0.30-0.35	TT pistol, steel-core bullet, 5 m	2 mm of steel plus SVM fabric
Vizit-2M, Russian Federation	6.2-6.8	0.30-0.35	AK74 assault rifle, 7N6 cartridge, 5 m	4 mm of steel plus SVM fabric
Body armor:				
P304-3, Belgium	3.0	About 0.25	Pistol, 9 mm, Rogo 640 cartridge, 5 m	3 mm of steel plus kevlar
P304-5, Belgium	6.8	About 0.25	AKM and AK74 assault rifles, 7N6M Model 43 cartridge, 15 m	5 mm of steel plus kevlar
Volya-2 standardized body armor, Russian Federation	29.5-31.3	About 1.16	AKM and AK74 assault rifles, 7N6M cartridge, 5 m	4.8 mm of steel plus SVM fabric
Armored suit, France	20.0	About 0.65	AKM assault rifle, 7.62 Model 43 cartridge, 5 m	—"—"—
Voin-K high-resistance protective assault suit, Russian Federation	About 60.0	1.40	SVD rifle, 5 m	7 mm of steel plus SVM fabric

A distinguishing feature of the shields, protective suits and body armor which were created is the use in them, as a rule, of steel armor plate elements, in some designs combined with SVM fabric (a domestic analogue of kevlar). This permitted substantially reducing the article's cost because of the relatively low cost of steel armor plate compared with SVM fabric. In addition—and this perhaps is the most important—use of steel armor plate permitted considerably reducing the dynamic characteristics of a bullet's effect on a person. This is especially important for protection against bullets of assault rifles and rifles possessing considerable energy.

By using three dimensional stamped armor plates, they succeeded in achieving a good body fit of means of individual armor protection and ensuring the possibility of concealed wear for certain models.

As already noted above, one specific direction of activity of the Russian Federal Counterintelligence Service is the work of technical explosive subunits, which are assigned missions of detecting, diagnosing, evacuating and disarming objects suspected of having homemade explosive devices present. These subunits were created in 1977 after Armenian nationalists set off a series of explosions in public places in Moscow. As a rule, homemade explosive devices are made under primitive conditions, as a result of which they present heightened danger when handled. In addition, antilift elements are used rather often in their design, which cause them to detonate when an attempt is made to remove them from where they are installed. To disarm the homemade explosive device in these cases, it must be disassembled at the place where it is installed without exploding it (i.e., ensure a breakdown of the structure without detonating the explosive charge). One possible method of realizing this operation can be to destroy the structure of the homemade explosive device by means of a high-velocity jet of fluid. In principle, such a jet can be generated by three methods:

- by actively propelling a "fluid" projectile from the barrel of a ballistic unit;
- by organizing the escape of fluid, forced out by a piston under the effect of the pressure of powder gases, from the body of the device through a nozzle of lesser diameter compared with the diameter of the body channel;
- by hydrocumulative propelling of a portion of fluid.

Main Characteristics of Hydrodynamic Destructors

Article Codename, Fluid Acceleration Method	Initial Velocity of Fluid (m/sec)	Type of Packaging Destroyed	Thickness and Material of Penetrable Test Obstacles (mm)
Vystrel-M, forcing fluid out through nozzle	300	Shipping boxes, briefcases, attache cases	Pine board, 25
Vyrub-RP, hydrocumulation from energy of powder	2,500	Cast iron, steel and aluminum pipes, "goose pans" [gusyatnitsa]	Two spaced steel plates, 4+2
Vyrub-RV, hydrocumulation from energy of explosive charge	2,900	Same as above	Same as above
Vyrub-DP 2, forcing fluid out through nozzle (double-flow balanced unit)	160	Shipping boxes, suitcases, briefcases, attache cases, doors	Pine board, 40

In assessing the capabilities of each method enumerated, determined based on results of research conducted by the Russian Federal Counterintelligence Service Technical Directorate during 1977-1990, it should be noted that the last one in practice permits providing greatest velocities of propelling a fluid, within the range of 2,500-2,900 m/sec, which exceeds by almost tenfold the magnitudes of the same parameter realized in the first two methods.

The Russian Federal Counterintelligence Service Technical Directorate created a family of hydrodynamic destructors of different power intended for nonexplosive dismantling of objects suspected to have homemade explosive devices present.

The destructors are used in the practice of technical explosive subunits of the Russian Federal Counterintelligence Service and have demonstrated the effectiveness of their action. The Vyrub-RP, Vyrub-RV and Vyrub-DP 2 articles have no foreign analogues.

In conclusion, the authors deem it necessary to note that a large collective of personnel of the Russian Federal Counterintelligence Service Technical Directorate and organizations of industry took part in developing the models of weapons, means of individual armor protection and technical equipment examined in the article. As a result of their successful work, it became possible to outfit operations subunits with this equipment.

Malakhit Design Bureau: Creator of the First Soviet Nuclear Powered Submarine

95UM0191E Moscow VOORUZHENIYE, POLITIKA, KONVERSIYA in Russian No 2 (5), 1994 (signed to press 27 Oct 94) pp 18-21

[Article by Anatoliy Valeryevich Kuteynikov, general designer and chief of Malakhit Design Bureau, corresponding member of St. Petersburg branch of Russian Engineering Academy, State Prize laureate; photograph of Kuteynikov included]

[FBIS Translated Text] *Anatoliy Valeryevich Kuteynikov completed the Leningrad Shipbuilding Institute and since then has worked in the design bureau which now bears the name Malakhit. For 18 years he was chief engineer and since 1992 has been general designer and chief of the design bureau. A corresponding member of the St. Petersburg branch of the Russian Engineering Academy, he received the State Prize Laureate title in 1994 for creation of new technology. Anatoliy Valeryevich stems from a family of shipbuilders. His great-grandfather developed the first Russian submarine, Petr Koshka, and built her in 1902 with his father's money; his grandfather was a participant of the defense of Port Arthur.*

The Malakhit Design Bureau was created in 1948 for developing submarines with energy sources independent of atmospheric oxygen. Such a submarine (Design Project 617) was created and tested. A government decree came out in 1952 on creating a submarine with an atomic engine, and our design bureau was completely reorganized for this task. The first Soviet nuclear powered submarine was developed in a short period of time (less than 5 years), was built in Severodvinsk and was named Leninskiy Komsomol. A series was produced under this design project, and submarines of this series are in formation to this day.

The first submarine with Volna ballistic missiles was diesel powered. In the late 1950's, when the nuclear powered submarine program had been expanded substantially, a portion of the work was transferred from it to the Rubin Central Design Bureau.

The design bureau created second-generation submarines, now the basis of the Russian submarine fleet, and later third-generation submarines.

A number of the design bureau's major engineering achievements can be noted, above all the introduction of titanium hulls. A fast submarine with the NATO codename Papa was created with such a hull.

Creation of the submarine Alfa, which to this day is considered unsurpassed, was a great engineering innovation. She is an integrated, automated submarine and she outstripped world submarine construction by 15-20 years. Unfortunately, Russia now cannot produce such submarines.

The design bureau created a unique diesel-powered submarine, Beluga, and as a research submarine she is the best in the world.

It must be said that our latest nuclear powered submarines are better than the American ones in noisiness and a number of other parameters, but we are lagging in the element base, electronics, and computer equipment, which naturally affects certain characteristics of our submarines.

The situation in the design bureau now is very difficult. The state is not paying for work already done and accepted. Clients owed us R23 billion as of the middle of

June. To this day the Ministry of Defense has not settled for work done in 1993. We would not like to turn a state defense enterprise into a commercial organization. If we take that path, who will create Russian armament and military equipment? The state of the submarine fleet in Russia is becoming alarming. The fleet is aging and practice operation has been reduced sharply.

We somehow are extricating ourselves and paying wages for now, and we are succeeding in keeping our workers' wages at a rather decent level for a state enterprise. In June they averaged R130,000, but around 400 workers are receiving R35,000-40,000, i.e., below the subsistence wage. We are forced to do this in order to hold onto highly skilled associates.

Our design bureau is aging; the collective's average age has reached 47 years and we absolutely need young cadres. World practice shows that efficient design collectives should have an average age of 30-40. When we were creating the first nuclear powered submarine, the collective's average age was 28. Before the USSR's disintegration the design bureau would get 50-70 young specialists a year, which permitted having the collective's age makeup close to optimum.

It must be said that the number of higher educational institution graduates in our specialty has dropped sharply of late. Thus, Leningrad Shipbuilding Institute previously graduated 30-40 persons in our specialty, but this year only 8. This is explained above all by the fact that our specialty is connected with complicated, difficult work and lengthy detached duty. Previously work in our design bureau was prestigious and paid rather well. Now the situation has changed and young people are not going into higher educational institutions for such specialties. We began paying young specialists R120,000, and those who completed higher educational institutions with honors R140,000. This caused a certain dissatisfaction among those who have worked in the design bureau for a long time now, but that policy permitted taking more than 40 graduates of higher educational institutions into the design bureau in recent months.

In addition to nuclear powered submarines, the design bureau has several other engineering directions. Since 1960 it has been engaged in developing manned deep-diving vehicles for the most varied purposes. In particular, they are used in enterprises of Mingeologii [Ministry of Geology] and in fisheries.

There is a specialization in small submarines, the chief designer of which is Yu. K. Minayev. The submarine Piranya was created in the design bureau as a diver submarine, i.e., it supported the delivery of divers to the work site and their exit directly out of the submarine in the depths. A combat version of the submarine armed with torpedoes and mines also was developed. Two such submarines were built; for now there have been no more orders, although there is great interest. Representatives travel here from all over the world, but no one is ordering the submarine for now; it turns out they are coming more for information than for purchases.

Another minisubmarine, Triton, weighs only 1.5 tonnes. She can be used for research and survey work and for combating underwater terrorists. Triton is operational with the Russian Navy.

Minisubmarines

Name	Developing Country	Length, m	Displacement, t	Diving Depth, m	Submerged Speed, kts	Crew	Operational Range, nm	Endurance, days
Piranya	Russia	30	250	Up to 200	6.5	4	130	10
Triton	Russia	5		Up to 40	6	2	30	

A number of pure conversion projects are performed in the design bureau. Several years ago we were assigned to develop equipment for manufacturing gelatin and bone meal. A design was created and prototypes were made, but the client is not paying for this work and we are unable to pay cooperating plants. The state granted us preferential credit of 3 percent, but the credit money was sent through commercial banks; they increase this interest to 13 percent, which naturally will be shifted to the product cost. For whom is this advantageous?

The design bureau has developed designs of hotels, tourist submarines, shops and so on, but no one buys them; no one has money.

The government of Moscow ordered a complex of structures for the Moscow River, but cannot pay for the work. The very same fate befell development of a northern mobile city for the geological survey on the Yamal Peninsula. They traveled here from Sakhalin and asked us to develop power plants for them. They liked our suggestion to create them on the basis of the power plants of nuclear powered submarines being decommissioned, but again there is no money to pay for this work.

We have experience in creating interesting, safe, ecologically clean underground atomic electric power stations. There is a great need for them, but no one has any money.

The design bureau initiated the establishment of the Rosshelf Joint-Stock Company, in which a number of defense complex enterprises have begun to operate. A number of design projects have been developed, including for surface vessels of the auxiliary fleet. Our design projects are recognized as advantageous and we are winning the contest. This was a program of real planned conversion. But in realizing the design projects we encounter the rigid opposition of bureaucrats, who consider it more advantageous to purchase everything abroad.

Thus, the design bureau is conducting varied work not just on underwater subjects. A rather large collective is required for this, but the economic situation led to where around 30 percent of workers left the design bureau in recent years. These basically are the best cadres. They are

getting jobs in various commercial structures, where they are paid several times more than in the design bureau. Such a situation is known to be characteristic of the entire defense complex. The amount of RDT&E is being reduced sharply and the country is losing the parity previously achieved with much difficulty.

The modern military submarine is a very complex object whose creation requires the involvement of workers of almost all technical specialties. Previously the entire country built a submarine; hundreds of various enterprises located on the territory of almost all republics took part in fabricating it. After the USSR's disintegration many cooperating enterprises ended up abroad and relations with them have become very complicated. Adjusting new cooperation requires enormous funds, but there is not enough even to pay for work already done.

Privatization of defense enterprises is doing enormous damage to the country's defense capability. Voucher privatization permitted some foreign firms to buy up a number of our defense enterprises cheaply. These firms are beginning to conduct their own policy, which is not connected with Russia's interests in any way. They follow a line toward completing our ships with western equipment. Our plants which previously were manufacturing set-completing articles remain without work. As a result, all cooperation is falling to pieces and it soon will turn out that Russia will be unable to build ships herself.

It should be noted here that although the Russian Federation bureaucratic apparatus now surpasses that which existed in the USSR in numbers, the number of specialists in the center who should carry on a unified technical policy in the armament area, particularly for nuclear powered submarines, has been reduced sharply. They no longer are capable of coordinating work being done, not to mention the need for drawing up future plans and programs. In my view, it is absolutely inadmissible to discharge from the Navy's ordering directorates good specialists who have just reached the so-called maximum age. People are taking their place who will not begin to understand very soon just what technical policy is.

Of course, the design bureau requires a technical overhaul. We have considerably more people working here than in similar western design bureaus. We need work automation, but there are no funds to do this. The money we receive from a client does not permit having a profit with which it would be possible to carry out renovation. Prices on materials, electrical power and so on grow continuously, but the cost of our work is agreed upon based on prices existing at the moment contracts are concluded.

The situation in Russia is such that an urgent revival of the Russian Navy is necessary, but the program existing today is a stillborn document. The question of financing it—the main question today—has not been studied at all. Cooperation for creating ships has been destroyed, and credits which Russia is granted by the West are expended as a rule to pay for the work of western firms based on conditions of the credit extension. Shipbuilding as a sector in Russia is perishing.

Previously 20-30 percent of funds were provided for RDT&E, but now they are only 3 percent. If this is not corrected, the results may prove to be very deplorable. While in Tula, the Russian Federation President said that priority financing of RDT&E will be ensured. One would like to believe that the promise will be realized. Despite the very difficult situation, I am firmly convinced that Russia will be restored to life and that it will have a powerful Navy. With this belief, we continue to work to create Russian submarines.

Kamov Firm Creates Highly Automated Helicopter Systems

95UM0191F Moscow VOORUZHENIYE, POLITIKA, KONVERSIYA in Russian No 2 (5), 1994 (signed to press 27 Oct 94) pp 22-28

[Interview with Sergey Viktorovich Mikheyev, General Designer of Ukhtomskoye Helicopter Plant OKB (Experimental Design Bureau), doctor of technical sciences, professor, academician of Russian Federation Academy of Transportation, Lenin Prize laureate, by VOORUZHENIYE, POLITIKA, KONVERSIYA, date, place and occasion not specified; photograph of Mikheyev included]

[FBIS Translated Text] *After completing Moscow Aviation Institute, Sergey Viktorovich Mikheyev worked in the Ukhtomskoye Helicopter Plant Experimental Design Bureau, which he has headed since 1974 in the position of General Designer. The following helicopters were developed under Sergey Viktorovich's direction and immediate participation: Ka-27, Ka-29, Ka-31, V-80, Ka-62, Ka-126, Ka-37 and others.*

Mikheyev is a doctor of technical sciences, professor, and academician of the Russian Federation Academy of Transportation. He was awarded the Lenin Prize for services in creating helicopter systems and has been decorated with orders.

[VPK] Sergey Viktorovich, please tell us about the history of the Kamov firm.

[Mikheyev] The firm's history began in 1940, when in accordance with an order of the People's Commissar of the Aviation Industry, construction of the country's first rotary-wing craft experimental plant began, based on structures at Ukhtomskoye Airfield. N. I. Kamov was appointed plant director and M. L. Mil his deputy. The plant's first task was to organize series production of the A-7 gyroplane developed by N. I. Kamov back in 1928.

A gyroplane detachment was formed on plant grounds at the beginning of the Great Patriotic War. It was made up of five craft, which were used for the first time at Yelnya as artillery fire spotters. The plant was evacuated to Sverdlovsk Oblast in October 1941 and disbanded in 1943.

Following the end of the war, OKB-2 was organized at an aircraft plant in Sokolniki in 1948 to create light helicopters and N. I. Kamov was appointed OKB chief designer. Later the experimental design bureau was transferred to Tushino and in 1955 to Ukhtomskoye near Moscow, where construction of the helicopter plant begun in 1940 was continued.

Nikolay Ilich Kamov headed up the Ukhtomskoye Helicopter Plant Experimental Design Bureau, which presently bears his name, until 1973. The following types of helicopters were developed under his direction from 1948 on:

- Ka-8 light helicopter (1948);
- Ka-10 single-seat ship-based liaison and observation helicopter (created in 1949 based on the Ka-8);
- Ka-15 two-seat ship-based helicopter, the first series helicopter of the experimental design bureau (1953);
- Ka-18 multipurpose four-seat helicopter (1956);
- Ka-25, the first Soviet ship-based ASW helicopter with a special set of electronic and sonar equipment and torpedo ordnance (1961);
- Ka-26 civilian multipurpose helicopter (1965), which became the most mass-produced Kamov helicopter and the first domestic helicopter to receive a western airworthiness certificate.

All these types of helicopters can be categorized as light, but Nikolay Ilich also worked on heavy craft. The Ka-22 heavy transport rotorcraft went out for tests in 1960. This was a fundamentally new type of flying craft, combining the merits of helicopter and aircraft. Eight world records in speed and load-carrying capacity were set in it in late 1961. Work on the rotorcraft was discontinued for a number of reasons, but provided the collective with exceptionally important experience in creating side-by-side rotor helicopters.

[VPK] What are the features of the Kamov firm's helicopters?

[Mikheyev] The Helicopter Scientific-Technical Complex (VNTK) imeni N. I. Kamov is one of two helicopter firms in Russia. The "working range" of helicopters created by Kamov personnel is rather broad, from light single-seat to heavy transport helicopter systems and from simple, cheap, commercial to sophisticated, ship-based helicopter systems on the cutting edge of science and technology. The firm follows a nontraditional path; the "calling card" of the Experimental Design Bureau imeni Kamov indisputably is a coaxial main rotor. A coaxial main rotor system (without tail rotor) gives helicopters an indisputable power and aerodynamic advantage. N. I. Kamov "saw" this at one time and dedicated his entire life to creating a coaxial main rotor design. What the coaxial rotor gives a helicopter is shown in the diagram.

There is no question that the design is complex and science-intensive in development. The experimental design bureau worked it out and brought it to operational perfection over two decades. But in our view, the coaxial rotor system which was worked out in actual designs and tested under very difficult conditions of shipboard operation can provide real advantages for 2-3 decades.

It also must be noted that for the first time in the world our firm began creating blades made of composite materials and today possesses unique technology for their fabrication. Such blades were installed for the first time on Ka-15 and Ka-18 helicopters.

Back in the 1960's we began not simply designing a helicopter, but tying in its design with flight equipment, i.e., designing a helicopter system.

All this provides advantages in certain areas of helicopter construction, above all ship-based helicopters. "Above all" not because other spheres of use of Kamov designs are less important, but because in early stages of creating Kamov helicopters it was specifically the Navy that believed in these helicopters and really supported N. I. Kamov. The modern Ka-27 ship-based helicopter created in the Experimental Design Bureau imeni Kamov to replace the Ka-25 is a very sophisticated search-strike air system that is based on an air-capable ship for many months of combat deployment. The helicopter is kept in a condition of combat readiness by the ground crew's efforts for all this time in isolation from the main base. The level of reliability of helicopter systems and of the onboard weapon system supports operation at any time of year or day, in good weather and in storms. The helicopter can perform a combat mission for four hours at a great distance from the base ship. And all this time a takeoff and landing area 10x10 m in size on the base ship, which may be on storm waves, is the only "bit of native soil" for the helicopter. During these four hours the ship herself proceeds tens of kilometers from the takeoff location.

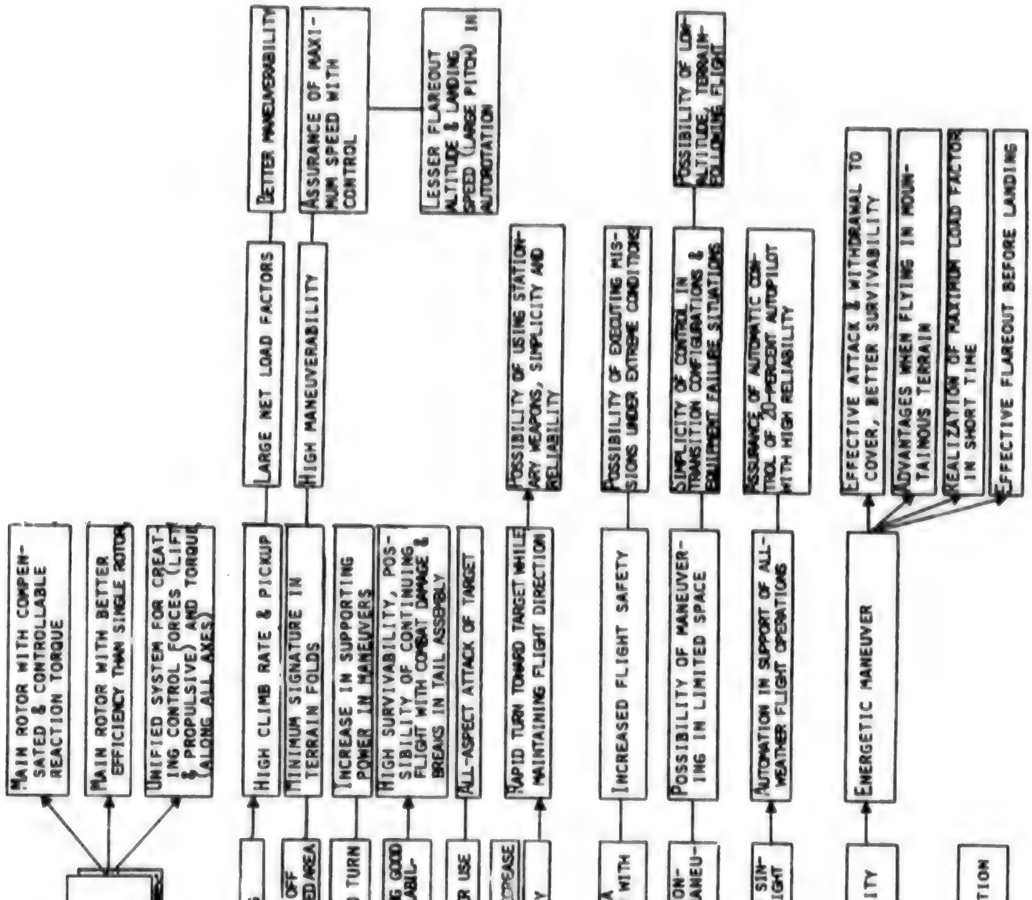
Combat work of hunting a submarine as a rule is carried out by a group of helicopters at a considerable distance from each other, but with respect to hardware the group's helicopters are connected in a unified information system. The primary search mode is a hovering mode when working with sonar; any displacements of the helicopter are impermissible here. This is supported to a greater extent by a coaxial main rotor design—symmetrical in control and simple in automation of flying processes. It stands to reason that such a helicopter system became possible to create with the confluence of efforts of many organizations and enterprises of defense sectors of industry and Ministry of Defense institutes.

In the late 1970's the question arose of creating a new combat helicopter to replace the Mi-24, which already by that time, in the opinion of military specialists, had become seriously inferior to western combat helicopters.

It was decided not to modernize the helicopter, but to create a new, highly effective combat system. Work done by Kamov personnel in advance in the area of creating an aerodynamic, coaxial main rotor design and highly automated electronic combat shipboard systems proved very "apropos" in this work. Having had a good result in the Navy, the Kamov personnel suggested not simply a combat helicopter, but a system.

After seriously analyzing conditions of land battle (also taking part in this work were institutes of industry—GosNIIAS [State Scientific Research Institute of Aviation Systems] and TsNIITM [Central Scientific Research Institute of Precision Machinebuilding]—and of the Ministry of Defense), the experimental design bureau put automation of flight and combat regimes and the provision for hardware coordination of helicopters over the battlefield into the project.

The V-80 helicopter was designed based these ideas; it later began to be called the Ka-50 (and "Black Shark" in the West) and it was the winner of a combat helicopter competition in 1986. State tests were completed in 1993,


COAXIAL HELICOPTER
COAXIAL ROTOR
MAIN ROTOR WITH COMPENSATED & CONTROLLABLE REACTION TORQUE
MAIN ROTOR WITH BETTER EFFICIENCY THAN SINGLE ROTOR
UNIFIED SYSTEM FOR CREATING CONTROL FORCES (LIFT & PROPULSIVE) AND TORQUE (ALONG ALL AXES)
ABSENCE OF TAIL ROTOR
AERODYNAMIC SYMMETRY
LARGE CONTROL FORCE ARMS
POWER GAIN
MINIMUM DIMENSIONS, WEIGHT, AND INERTIA MOMENTS
NO RESTRICTIONS ON HELICOPTER ANGULAR VELOCITY
CLASSIC AIRCRAFT TAIL ASSEMBLY CONFIGURATION
POSSIBILITY OF TAKEOFF & LANDING WITH ANY WIND MAGNITUDE & DIRECTION
POSSIBILITY OF PERFORMING DEEP SLIPS
SIMPLICITY IN PILOTING & ACCESSIBILITY FOR PILOT OF ANY SKILLS
INDEPENDENCE OF LONGITUDINAL & LATERAL MOVEMENT
INDEPENDENCE OF CONTROL CHANNELS
POSSIBILITY OF CREATING HIGHLY EFFECTIVE AUTOMATIC STABILIZATION & CONTROL SYSTEM
HIGH EFFECTIVENESS AND POWER OF CONTROL
INCREASED OPERATING CENTER-OF-GRAVITY RANGE
HIGH STATIC CEILING
POSSIBILITY OF TAKING OFF FROM & LANDING ON LIMITED AREA
POSSIBILITY OF RAPID TURN
POSSIBILITY OF PROVIDING GOOD STABILITY AND CONTROLLABILITY CHARACTERISTICS
ASSURANCE OF ALL-WEATHER USE
EFFECTIVE TURN RADIUS DECREASE
SUPERMANEUVERABILITY
POSSIBILITY OF CREATING A SINGLE-SEAT HELICOPTER WITH BROAD MISSION PROFILE
BETTER STABILITY, CONTROLLABILITY AND MANEUVERABILITY
EFFECTIVE AUTOMATION OF SINGLE SEAT HELICOPTER FLIGHT
BETTER CONTROLLABILITY
SIMPLICITY OF OPERATION
HIGH CLIMB RATE & PICKUP
MINIMUM SIGNATURE IN TERRAIN FOLDS
INCREASE IN SUPPORTING POWER IN MANEUVERS
HIGH SURVIVABILITY, POSSIBILITY OF CONTINUING FLIGHT WITH COMBAT DAMAGE & BREAKS IN TAIL ASSEMBLY
ALL-ASPECT ATTACK OF TARGET
RAPID TURN TOWARD TARGET WHILE MAINTAINING FLIGHT DIRECTION
INCREASED FLIGHT SAFETY
POSSIBILITY OF MANEUVERING IN LIMITED SPACE
AUTOMATION IN SUPPORT OF ALL-WEATHER FLIGHT OPERATIONS
ENERGETIC MANEUVER
LARGE NET LOAD FACTORS
HIGH MANEUVERABILITY
POSSIBILITY OF USING STATIONARY WEAPONS, SIMPLICITY AND RELIABILITY
POSSIBILITY OF EXECUTING MISSIONS UNDER EXTREME CONDITIONS
SIMPLICITY OF CONTROL IN TRANSITION CONFIGURATIONS & EQUIPMENT FAILURE SITUATIONS
ASSURANCE OF AUTOMATIC CONTROL OF 20-PERCENT AUTOPILOT WITH HIGH RELIABILITY
EFFECTIVE ATTACK & WITHDRAWAL TO COVER, BETTER SURVIVABILITY
ADVANTAGES WHEN FLYING IN MOUNTAINOUS TERRAIN
REALIZATION OF MAXIMUM LOAD FACTOR IN SHORT TIME
EFFECTIVE FLAREOUT BEFORE LANDING
BETTER MANEUVERABILITY
ASSURANCE OF MAXIMUM SPEED WITH CONTROL
LESSER FLAREOUT ALTITUDE & LANDING SPEED (LARGE PITCH) IN AUTOROTATION
POSSIBILITY OF LOW-ALTITUDE, TERRAIN-FOLLOWING FLIGHT

the helicopter was mastered in series production and it is ready to become operational in that form and with those realized solutions which move it to the level of significant achievements of Russian helicopter construction. In the opinion of one of the Air Force command representatives who evaluated the Mi-28 and V-80 combat helicopters during 1985-1986, the Mi-28 is a good machine and the V-80 is not simply a good machine, it is a new direction. Much in the V-80 can be characterized in the superlative and by the phrase "for the first time in the world." For the first time in the world a combat helicopter system has been created that is controlled by a single pilot. Its automatically controlled antitank system has no equal in the world in effective range and delivery accuracy; the accuracy of the gun unit surpasses by several times similar weapons on the best U.S. combat helicopter, the AH-64 Apache; for the first time in the world an ejection system has been created for saving the pilot when the helicopter receives combat damage; the V-80 helicopter has no equal in level of armor protection, and so on.

The helicopter was designed to operate in a "system." It is outfitted with equipment for receiving and transmitting a precise target designation in an automatic mode. All this is realized in the series-produced helicopter. The V-80 has real capabilities for building up combat potential and combat might. We see these ways and are proposing them.

The helicopter was created in closest collaboration with such organizations of industry as GosNIIAS, TsAGI [Central Aero-Hydrodynamics Institute], LII [Flight Research Institute], TsNIITM, KBP [Design Bureau of Instrument Building] (A. G. Shipunov), KMZ [not further expanded, possibly Krasnogorsk Machinery Plant] (V. V. Nekrasov), Elektroavtomatika LNPO [not further expanded, possibly Lyubertsy Scientific-Production Association], Zvezda PO [Production Association] (G. I. Severin), Arsenyev Progress AK [Aircraft Company] (V. I. Manoylenko) and many others impossible to mention in one article, but to which we are deeply grateful. Ministry of Defense institutes took a large part in creating the helicopter. CINC Air Force P. S. Kutakhov and Minister of the Aircraft Industry I. S. Silayev at one time personally devoted much attention to this competition work and supported this helicopter.

Work on the Ka-50 brought joyful minutes—after all, an absolutely nontraditional path of designing a combat helicopter had been conceived and realized; a result was obtained which confirmed the desired characteristics in state tests and in our view provided a rather good base for subsequently building up the potential of the system of Army aviation combat helicopters. But on the other hand, all sorts of delays in making a decision to place this helicopter in the inventory time after time force us to try to prove obvious things and divert the designers' primary potential from solving genuinely important engineering problems.

[VPK] Sergey Viktorovich, previously all the firm's work was done under a Ministry of Defense order. Does this mean that everything previously created by the experimental design bureau is suitable only for defense needs?

[Mikheyev] In fact, we were creating military equipment first and foremost previously, but helicopter construction is the most adaptive sector of the defense industry. Our models of former military equipment are opening up ever newer spheres of national economic application for themselves. The majority of our helicopters can be included among dual-purpose equipment—for defense and for the national economy. This was provided for back in the A-7 gyroplane. First Class Diplomas and Gold Medals were awarded to the Ka-15 civilian version in 1957 and to the Ka-18 in 1958 at the Brussels World Exhibition.

In 1961 the Ka-15 began to be stationed on the nuclear powered vessel Lenin for ice reconnaissance. In 1974 Ka-25 helicopters took part in clearing mines from the Suez Canal.

Our Ka-32 helicopter, created on the basis of the Ka-27 Navy ship-based ASW helicopter, gave an excellent account of itself in transport movements, in unloading vessels, in escorting ship caravans along the Northern Sea Route, and in logging here in our country and abroad. It recently was equipped and tested in an uncommon area of application such as putting out fires. Several specially equipped firefighting helicopters went on a Moscow fire safety watch. Today the Ka-32 is the only helicopter in Russia certified as conforming to airworthiness standards, which gives it the right to operate over cities and built-up areas. It has excellent capabilities for performing service in MVD subunits (inasmuch as it has increased combat survivability), in fighting the drug trade, and in supporting customs operations. It is excellently adapted for work over the sea and on oil shelves—this is its area of application. And just recall the unique operation for precision installation of dosimeter gear from a great height into a smokestack of the demolished Chernobyl Atomic Electric Power Station. The helicopter, created on the basis of a combat helicopter and with funds which the state allocated at one time for national defense, has all these unique capabilities. So has the people's money really been wasted? And did it really not return a hundredfold through the most sophisticated equipment? And are the collectives which possess unique experience and an advanced experimental and production base really not the people's property? The so-called defense industry is inseparable from the rest of the country's industry and is its best part.

In today's situation one only has to make proper use of accumulated potential, correctly use the capabilities presented and get businessmen in the country and abroad interested. The state also should show concern for its scientific-technical potential and support its defense establishment. That which has accumulated and into which money has been invested for many decades must work and turn out new potential.

It is obvious that there is a clear surplus in the area of arms, especially for present-day conditions. But a thrifty attitude specifically presumes a reasonable reduction, not an indiscriminate curtailment of programs without considering Russia's future interests. The fact is that not one of the West's military programs in the field of helicopter construction has been closed. Moreover, new technologies are being created there and new and promising directions are being worked out. And if one says that the West is not threatening us, then at any rate the market of arms and advanced military technologies is being successfully captured by

western firms today, and the fact is that this is a very expensive market in which our country had firm positions until recently.

Unfortunately, one does not have the feeling now that Russia has its own military program. It must be balanced with consideration of capabilities and present-day conditions. In our view, the role of military science grows especially in this connection; military science must assume responsibility for creating such a program without waiting until the situation in the country stabilizes or becomes even worse. Industry also needs this program, because we must be sure of a guaranteed order for the products we are developing, if of course they are made in accordance with Ministry of Defense requirements. This confidence in the final account will stabilize the situation in the experimental design bureau and at series plants.

[VPK] What is the status of the Kamov firm today?

[Mikheyev] The Helicopter Scientific-Technical Complex imeni Kamov became the Kamov Open Joint-Stock Company. We own the controlling block of shares. Although it is difficult for us, as it is for many today, we still are working, seeking, and finding new orders, and we believe the main task today is to give people permanent jobs and pay and ensure that pay is indexed regularly. In my view, constructive measures have been found which will permit stabilizing our economic activity and financial situation. We have succeeded in preserving the defense order, albeit in reduced form; in including a number of topics on new civilian helicopters in the state plan; in beginning realization of commercial contracts, and so on. Work was being carried out on a little over 20 topics in 1993.

Financial circumstances force us to seek sources of financing that are nontraditional for us. Here I would like to mention once again the Ka-32 helicopter, which was created in two main versions during 1980-1983: Ka-32T, a helicopter for transport and for performing construction, installation and search and rescue operations; and Ka-32S for conducting ice reconnaissance while escorting ships and for unloading them. Six world records were set in the Ka-32 during 1983-1984. Now we have concluded contracts for leasing the Ka-32, for re-equipping the Ka-32 as the Ka-32A, and for creating a firefighting helicopter for the city of Moscow. Several helicopters have been prepared for the firefighting service under a contract with the Moscow Government. We assumed the obligation to organize flight duty and ensure alert duty of helicopters. Such duty has been supported since March of this year. All this adds to the experimental design bureau's financing.

In 1993 we succeeded in realizing a number of important points: the Interstate Aviation Committee and the Aircraft Register issued a certificate for the Ka-32A helicopter, and thus the Ka-32 became the first Russian helicopter to receive such a document. Its appearance opened the way for us to perform commercial operations, for flight operations over cities, for cooperation with foreign countries over territories of CIS countries and so on. The Russian airworthiness certificate permitted us to submit requests for certification to countries of Europe and America.

The firm is working to create commercial and multipurpose helicopters. The Ka-62 multipurpose commercial helicopter has been developed which can carry 15-16 passengers, and the Ka-126 and Ka-226 commercial helicopters are being developed.

Along with this, the firm continues work to create helicopter systems for the Ministry of Defense. Development has been completed on the VK RLD [radar patrol helicopter system] Ka-31 radar patrol helicopter, and work is under way on other orders. Almost all helicopters are being developed as dual-purpose equipment.

What determines the firm's technical level today? Of course, not the old services it performed, although the foundation of today's proposals formed 10-15 years ago. This is an ordinary phenomenon. In this respect the Kamov firm has a rather good "portfolio" of proposals. Historically it so shaped up over decades of work that the Experimental Design Bureau imeni Kamov specialized in creating sophisticated, highly automated helicopter systems. Our ship-based ASW helicopter systems at the very least concede nothing to the best similar foreign ones; the radar patrol helicopter system that we created with an antenna that is put out and rotates in flight and is commensurable in dimensions with the helicopter itself has no analogues abroad; and the Kamov firm created the world's first single-seat combat helicopter with a highly automated, integral complex of onboard equipment and weapons.

The firm does not copy even the best existing foreign models, because each copy is a lag behind the original. We follow our own path even if in so doing it is necessary to revise postulates that previously seemed immutable.

It can be said that the firm assesses its future rather optimistically, albeit without an excess of self-assurance.

Combat and Sports Aircraft of the Sukhoy Experimental Design Bureau

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[Article by Mikhail Petrovich Simonov, General Designer of Sukhoy Experimental Design Bureau, Lenin Prize laureate, member of International Engineering Academy and Russian Engineering Academy; photograph of Simonov included]

[FBIS Translated Text] *Mikhail Petrovich Simonov completed Kazan Aviation Institute. He began designing aircraft from his school days. In Kazan he was chief designer of a sports aircraft design bureau he established while a fourth-year student. As a result of difficult relations with the Kazan CPSU Oblast Committee leadership, he was forced to transfer to the Dolgoprudnyy Design Bureau, and later he worked as first deputy to well-known aircraft designer Robert Bartini. He worked in the P. O. Sukhoy OKB [Experimental Design Bureau] from 1970 as deputy chief designer, headed up an experimental team on the Su-24 aircraft, in 1973 became chief designer of the Su-27 fighter and first deputy General Designer, and in 1983 he became Sukhoy OKB General Designer.*

The Su-25TK, Su-27S, Su-30, Su-30MK, Su-33, Su-34, Su-35, Su-26, Su-29 and Su-31 aircraft were developed and series-fabricated under his direction, and developments of new advanced aircraft systems and civilian aircraft also have been conducted under his direction.

Mikhail Petrovich is a Lenin Prize laureate and member of the International Engineering Academy and Russian Engineering Academy.

The Sukhoy OKB Aircraft Scientific-Production Complex (ANPK) is one of the world's largest aircraft firms. Pavel Osipovich Sukhoy, USSR Academy of Sciences Academician, Twice-Honored Hero of Socialist Labor, and State and Lenin prize laureate, was creator of the OKB and subsequently the first General Designer in the period 1939-1975. Many well-known combat aircraft were created, including the Su-2, Su-6, Su-7B, Su-11, Su-15, Su-17, Su-24 and T-4, and the appearance of the Su-25 and Su-27 aircraft took shape under his direction.

According to the logic which existed previously in the OKB, a new aircraft was created to counterbalance some foreign aircraft, and so they tried to make it better than the enemy aircraft. Thus, the Su-24 bomber was created against the U.S. F-111 and the Su-27 fighter against the F-14, F-15, F-16 and F-18. The Su-27 became a certain milestone in OKB activity. It has been recognized by specialists around the world as one of the best modern fighters. The aircraft received a high evaluation abroad for the first time in 1989 at an air show held regularly in the United States at the dual airfield of the International Airport and the National Guard Airport in Oklahoma. At that time air show general director Tom Jones invited us to come with the Su-27 and Su-26. We received permission to take part in the air show and thus ended up in Oklahoma.

Unfortunately, Jones himself died at this air show in executing a risky trick at extremely low altitude in our Su-26 sports aircraft. According to accepted tradition in America, we continued the flights after his death. On the final day of the air show all participants saluted Jones by making one grandiose flight over the site of his death.

At this air show our aircraft also were flown by foreign pilots, who gave a high assessment of the Su-27 fighter, placing it above the U.S. F-15 and F-16. The Americans declared that our aircraft's maneuverability was so high that they would have to revise close-in combat tactics and requirements being placed on fighters under development.

Later the Su-27's superiority was confirmed repeatedly by our own and foreign specialists at various air exhibitions. Thus, our Russian Knights group from Kubinka won a demonstration battle in the Su-27 against the F-15. The Americans became convinced of the Su-27's advantage in close-in combat.

Similar Su-27 flights were conducted at Farnborough in England, where first British Tornado fighters and then Hawk fighters opposed our aircraft. The British aircraft were flown by Flight Test Center pilots, who acknowledged the Su-27's superiority based on results of the flights.

The aircraft really did turn out to be a good one. Thirty-four world records were set in it, and records of U.S. F-15 and F-16 fighters were surpassed. But all this has become the property of the press only at the present time; the history itself of creating the Su-27 was not simple.

When the Su-27 had gone through state tests, it was written in the acceptance certificate that it basically conformed to given requirements, but was inferior to the best foreign fighter aircraft, the F-15. By this time the aircraft had begun to be produced in series.

At this time the OKB had completed studies for a comparative evaluation of the Su-27 and similar foreign aircraft. The studies were conducted by a specially organized department which kept dossiers on new aircraft being produced in the world. The analysis showed that the aircraft created by the OKB was integrally inferior to the F-15 fighter by approximately 35 percent, although previously it had been believed that it would surpass the American fighter in certain of its characteristics.

Based on the analyses and calculations which had been made, the heads of the OKB decided it was necessary to suspend series production of the aircraft. We succeeded in persuading Deputy Minister of the Aircraft Industry I. S. Silayev of the correctness of that decision, although this was no simple matter. Twelve aircraft had been fabricated by the time series production was halted.

The OKB redesigned the aircraft; the ejection seat and size of the main wheel tire remained from the old aircraft. An essentially new aircraft appeared as a result. It has powerful armament and is outfitted with sophisticated computers and automatic equipment which help realize the aircraft's high maneuverability. Powerful armament gives the Su-27 superiority in combat at long ranges, and high maneuverability does the same in close-in combat.

The previous Su-27 designation was preserved for the newly created aircraft, it was given a good workout in tests, and now this is a reliable, highly effective fighter. Subsequently the Su-27 became the basic aircraft in creating an entire family of aircraft in the OKB.

The Su-30 is a two-seat version of the Su-27 and is used as a command post for formation and unit commanders and as a trainer aircraft.

The Su-30MK is a two-seat fighter-attack aircraft. It has powerful missile armament and is capable of destroying targets in the air, on land and on the water. The armament also includes antiradar missiles capable of effectively engaging SAM systems. The Su-30MK has no suspended tanks in order to be less noticeable to radars, but it is capable of making long flights with aerial refueling. The aircraft made a nonstop flight over a distance of more than 14,000 km with three refuelings.

The multipurpose Su-33 aircraft is intended for arming new aircraft carriers.

The Su-34 front bomber was created to replace Su-24 and Su-24M bombers. The Su-34 has a range of 4,000 km without refueling and range essentially is unlimited with refueling. It is equipped with a new onboard digital computer and modern electronic and navigational equipment and carries guided, including homing, weapons. The aircraft has a spacious, two-seat cockpit permitting the pilot

to rest, which increases the aircraft system's combat effectiveness. The navigation equipment permits flying at extremely low altitudes in nap-of-the-Earth flight and thus penetrating air defense zones.

Finally, the Su-35. It was created with consideration of requirements of various customers, including foreign customers.

And so the Su-27 family is rather extensive. Although family types differ significantly, the level of standardization is over 80 percent. This is an enormous achievement of the Sukhoy OKB Aircraft Scientific-Production Complex.

The OKB creates more than just combat aircraft. The history of sports aircraft construction in the Sukhoy OKB began in 1984, when the United States won the world championship in sports aviation for the second time. Soviet sportsmen performed in the YaK-50 sports aircraft and suffered a defeat. Moreover, three crashes in a row occurred in these aircraft. Commissions which investigated these crashes were unable to clarify their real cause and concluded that the aircraft were destroyed through the pilots' fault. The danger of a fourth crash impended.

I was invited to the DOSAAF [Volunteer Society for Cooperation with the Army, Air Force and Navy] Central Committee to consult unofficially on the question of remedying the crashes in the YaK-50.

An analysis of the YaK-50 aircraft that were being operated showed that almost all had cracks in spars and stabilizer deformations which could lead to a breakup of the aircraft with further operation. The OKB engaged in a careful study of flights in sports aircraft. In aviation it is believed that a pilot loses the ability to control an aircraft with load factors greater than 9. But this is true of pilots who are not of a youthful age, when health no longer is optimum and emotions are controlled by experience. Based on the maximum load factor of 9, sports aircraft were designed so as to withstand breaking loads of 12.

We arranged a centrifuge experiment where the subject did not know the amount of the load factor and had to line up sight crosshairs with the image of a target on a television screen. It was learned that sports pilots continue controlling the aircraft with load factors greater than 9 and in the excitement of the sport may go beyond a load factor of 12, i.e., beyond the aircraft's ultimate strength, which led to the crashes. We simultaneously concluded that pilot cockpits were poorly made from the standpoint of load factors, inasmuch as the height of the hydrostatic column for a pilot, i.e., how high the head is above the feet, turns out to be very large.

The OKB decided to create its own sports aircraft with a new cockpit in which the seat was made so it was easier for a person to endure high load factors; there is also a significant reduction in the height of the hydrostatic column. During g-loads, flows of blood from the head and from the legs meet in the pelvic area and substantially balance out. The pilot can withstand load factors up to 12 or more. Therefore with consideration of a safety factor of 1.5, the aircraft design should withstand load factors up to 18. TsAGI [Central Aero-Hydrodynamics Institute] demanded that our aircraft conform to load factors of 24. An aircraft made of conventional materials would turn out to be too heavy for such load factors. We used composites, which justified our hopes.

The Su-26 sports aircraft was created quickly in the OKB. In 1986 B. V. Rakitin, chief designer of the Su-26, traveled together with a Soviet team to international competitions in the United States. The team became world champion. Since then we have been regularly confirming the title of strongest by taking first and second places.

Subsequently the Su-29 two-seat sports aircraft was created, and now the new Su-31, in which we took into account accumulated experience of operating the aircraft under conditions of sports competition, already has begun to be produced.

We are providing the Russian national team with sports aircraft and are selling the single-seat Su-26 and two-seat Su-29 to other countries. An American firm is the OKB's distributor. Five aircraft have been sold abroad in each of three years. For the fourth year we suggested reducing the cost of the aircraft by 20 percent and the demand for them increased so much that now we cannot fully satisfy it. We began selling approximately 20 aircraft a year: 22 were sold in 1993 and 14 for the first half of 1994. Now the cost of one of our sports aircraft is $170,000-200,000. We believe the price has to drop even further to increase demand. At the same time, we are building up the production of sports aircraft. We have included the Dubna Machinebuilding Plant in this and figure on bringing the output up to 50 aircraft per year. To improve sales of an increasing number of aircraft, we are examining with our distributor various ways of accomplishing this (options, pricing policy).

It must be said that there have been good comments about our sports aircraft abroad. Thus, Japanese specialists write that the Su-26's superiority over other sports aircraft is ensured by the Sukhoy OKB firm, which creates superb fighters. The approaches in creating these two classes of aircraft are rather similar.

In conclusion I would like to say a few words regarding industrial-finance corporations. We completed the establishment of the Sukhoy Aircraft Construction Corporation; it included almost all cooperating enterprises taking part in building Sukhoy aircraft, including aircraft plants in Komsomolsk-on-Amur, Irkutsk and Novosibirsk, developing enterprises, and manufacturers of flight equipment and gear. Yalosbank represents the financial part, and talks are being held with certain other banks which are ready to invest funds in long-term advanced projects. We hope the Sukhoy Aircraft Corporation will play a prominent role in Russian aircraft construction.

When Will the Cruiser Petr Velikiy Become Operational?

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[Article by Oleg Borisovich Shulyakovskiy, president of Baltic Yard Joint-Stock Company, member of St. Petersburg branch of Russian Engineering Academy; photograph of Shulyakovskiy included]

[FBIS Translated Text] *Oleg Borisovich Shulyakovskiy completed the Gorkiy Polytechnical Institute Physics Faculty in 1971. As a specialist in atomic power plants, he was sent to the Baltic Yard, where he worked as engineer and shop superintendent, and became general director in 1992. Now Oleg Borisovich is president of the Baltic Yard Joint-Stock Company and a member of the St. Petersburg branch of the Russian Engineering Academy.*

The Baltic Yard was founded in 1856 after the end of the Crimean War, above all for building Russian warships. The yard was one of the largest and oldest of Russia's shipbuilding enterprises. Its products are known throughout the world: they are the most powerful nuclear powered icebreakers and scientific research ships, oilers and ore carriers, nuclear powered missile cruisers and cargo-passenger steamers. Well-known warships were built at the Baltic Yard in the 19th century: frigate Admiral Lazarev (1869), clipper Plastun (1879), semiarmorclad frigate Vladimir Monomakh (1883), cruisers Admiral Nakhimov (1887) and Pamyat Azova (1890) and armorclad Admiral Ushakov (1896). The following were launched at the beginning of the 20th century: cruiser Gromoboy (1900), battleship Knyaz Suvorov (1904), battleship Sevastopol (1914) and submarine Bars (1915). The yard built a total of 100 warships before the 1917 October Revolution.

In the post-October period the yard launched many different ships: timber carriers, cargo-passenger and fishing vessels, scientific research ships and warships. The oilers Varshava (1960) and Velikiy Oktyabr (1973), scientific research vessels Kosmonavt Vladimir Komarov (1967) and Kosmonavt Yuriy Gagarin, and five nuclear powered icebreakers, Rossiya, Arktika, Sibir, Sovetskiy Soyuz and Yamal, were built here. Kirov-Class nuclear powered missile cruisers slid down the ways of the Baltic Yard; the last of them, Petr Velikiy, cannot leave the yard in any way.

The yard has three specialties in addition to shipbuilding: ship machinebuilding, metallurgy and consumer goods production. Thus, the yard is a comprehensive shipbuilding enterprise where much is produced that a ship needs. Production of large propellers should be noted especially. The Baltic Yard supplies all shipyards of the former USSR with propellers. We produce such ship machinebuilding products as steam boilers and steam generators.

The Baltic Yard and its workers are the founders of many shipbuilding enterprises, including yards at Severodvinsk and Nikolayev.

The situation has changed sharply at the yard in recent years. Construction of several Kirov-Class cruisers (i.e., nuclear powered missile cruisers), long-range space reconnaissance ships and a series of nuclear powered icebreakers was envisaged back in the late 1980's, but almost the entire military program was curtailed on the threshold of 1989. While the volume of the yard's military products was over 80 percent during 1987-1988, in 1993 it was reduced to 7 percent. The reduction in military orders proceeded spontaneously and no sensible conversion programs and plans existed. Therefore the yard has been forced to shift to commercial shipbuilding. Of the old orders, only one nuclear powered icebreaker, Ural, and one nuclear powered missile cruiser, Petr Velikiy, are being fitted out.

The yard mastered construction of commercial vessels such as Ro-Ro ships and chemical tankers. Ro-Ro ships are vessels intended for transporting wheeled and tracked vehicles, equipment on roll-trailers and containers up to 2.59 m high. Construction of these vessels began back before disintegration of the USSR. The first vessel was turned over to the Baltic Shipping Company in 1982 and now one more vessel has been launched and a third is being fitted out. The Baltic Shipping Company now is in no position to buy these vessels and so the yard is seeking customers; two Ro-Ro ships most likely will be sold to Novorossiysk and construction of Ro-Ro ships in all likelihood will end with this.

The yard signed a contract with Germany in 1993 to build a series of 12 chemical tankers. These are very sophisticated vessels; we are to turn over one vessel this year and a second one in 1995. The contract firmly stipulates construction only of two tankers; this work is going normally and is profitable for the yard.

Late last year the yard signed a contract with a Norwegian firm to build six large vessels, bulkers, displacing 48.000 tonnes. With its capacity, the yard is capable of taking on another large order, and there are many proposals, but we would like to build a sophisticated vessel, preferably with an atomic engine, inasmuch as the yard specialized in this direction for a long time. The Russian Navy wishes to order such a ship, but it is unclear whether or not it will have the necessary funds.

The yard continuously encounters difficulties engendered by the fact that the Russian Government is not paying its debts. This is well illustrated by the fate of the cruiser Petr Velikiy. The ship is 90 percent ready, but money for her completion is not coming in. It turns out that when previously allocated money does arrive, the prices of contracting parties already are substantially higher than those which were agreed upon at the moment the estimate was compiled. Therefore the yard is in no position to use the money received to pay for the work of contracting parties. The impression is created that we never will turn over the cruiser, although all time periods were up long ago. In early 1994 we were confident the cruiser would be completed this year, but now there is no such assurance. The Russian Ministry of Defense leadership promises a great deal, but does not provide timely payments. In mid-June of this year First Deputy Minister of Defense A. A. Kokoshin was in St. Petersburg and was discussing problems connected with completing construction of the ship and constructing a new class of cruisers. But to this day the Russian Ministry of Defense is not ready to realize the fact that our construction cost will be close to world prices. The faster the Ministry of Defense realizes this, the better it will be for everyone. If there is to be a large interruption in military orders, the Baltic Yard will be completely restructured in a few years, it will become unprofitable for it to fulfill defense orders, and specialists necessary for this will not be left at the yard.

The Murmansk Shipping Company is the client for the icebreaker Ural and construction is being paid for by the Ministry of Transportation and Department of the Maritime Fleet. The financial situation here is even worse than with the cruiser.

If one seriously assesses the prospects, it must be admitted that our country has turned out to be technologically backward and incapable of creating competitive products in many directions. Previously this situation was camouflaged by military orders, and the distortion of prices which existed concealed the bitter truth that we build vessels that are more expensive than in Europe, not to mention South Korea and Japan, by an order of magnitude. Now existing tax policy and the growth of prices on materials and energy carriers led to where our products are no cheaper than existing world prices. There is only one way out of this situation, one which the entire world has followed—investments, complete technological retooling, and on this basis the creation of modern shipbuilding technology, which will permit producing competitive products.

This also goes for the Baltic Yard, which requires technological retooling. We are taking serious steps in this direction. First of all, we were forced to set up our own design bureau, because to this day ship designers in Russia largely are working in the old way and an enormous number of drawings still are on Kuhlman drafting units. The modern world has not worked that way for a long time. In creating chemical carriers the Baltic Yard completely rejected the services of designers from other organizations; our design bureau is working with foreign design firms and working documents are made by the yard design bureau. The yard learned to build a ship hull without drawings. A control program is created in the design bureau and it is transmitted to the yard directly from the designer's workstation. That is how the yard has built the hulls of two vessels already.

Secondly, we began purchasing licenses for different parts of ships. In Germany we bought a license for building vessel spaces, and we purchased equipment. Today we have an experimental cabin and we have to buy certain other things. With the transition to new technology, construction costs are lowered by tens of times inasmuch as much work is excluded (woodworking, painting and so on). Now we are purchasing a license for producing ship's furniture and are purchasing the equipment for this work, later we will buy a license for ship's boilers and so on.

In the last two years we have created a document called the "Baltic Yard Business Plan," which has undergone international expert examination. The "Business Plan" concerns all aspects of yard activity. It reflects the computerization of all management and design processes and it reflects the yard's structural and technical reorganization. Realizing the first phase of the plan requires around $150 million. The very first thing in this plan is to create a new steel cutting shop, inasmuch as the shop which existed at the yard was built in the last century. As a result of renovation, shop productivity will be 60,000 tonnes with the participation of 15 workers (the shop which existed could cut 20,000 tonnes of products with great difficulty, and 200 persons worked in it). The equipment for the new shop is being bought in the West and the technology is being developed together with yard specialists.

The assembly production wing is being fully renovated and many processes, above all metal welding, are being mechanized and automated in parallel. Later an enormous wing will be renovated for fabricating vessel modules weighing up to 2,000 tonnes, and a shop will be created for fabricating ship pipes according to modern technology.

The entire renovation plan is designed for five years and its realization will permit the Baltic Yard to catch up with leading European firms in costs, quality and rates of fabrication of ships. The question is where to get the money.

The Russian Government provides no funds for renovation, and Russian commercial banks for now are only taking a look: now they prefer to deal with "fast" money, i.e., to finance trade operations. We were forced to turn to the European Bank for Reconstruction and Development and managed to interest it. On 21 June 1994 the Bank's board of directors decided to finance construction of bulkers at the yard. The experts studied our "Business Plan" and also concluded the advisability of participating in renovating the Baltic Yard.

There are a number of western firms ready to purchase shares of the Baltic Yard Joint-Stock Company. We are taking a cautious approach to this and are analyzing the situation carefully. The state's share in the Baltic Yard Open Joint-Stock Company now is 20 percent, and a certain portion of these shares will be sold after completion of voucher privatization. Of course, the yard is interested in Russian investors, in those who would be able to finance the yard's traditional products, i.e., enormous cruisers and icebreakers. Unfortunately, there have been no specific steps on the part of the Russian Government. There is a program for reviving the Russian Navy, but it was drawn up in the old traditions. There are no specific measures in the plan, and sources of financing are absent. But the saddest thing is that 80 percent of ships in this program are planned to be built at western yards, i.e., if such a program is carried out, it will be a program for development of western shipbuilding. It must be said that this trend did not become apparent overnight. Western shipyards built ships for the Soviet Union for many years and at considerably higher prices than were paid for the very same construction inside the country. Ships were built above all at yards of the FRG, Yugoslavia and Finland.

Unfortunately, the yard cannot operate as western firms do, i.e., take on credit and settle after selling the constructed vessels. The yard simply cannot operate under this arrangement with the existing inflation rates and level of bank interest for credit. Now the Russian Government and various shipping companies are continuing to build ships in the West. Frequently this construction is being financed by western credits, with this condition stipulated in advance when they are granted. Russia's debt is growing in this way.

Today the Baltic Yard is working rather successfully in the area of ship machinebuilding. We build and sell propellers for Ukrainian enterprises. There are many orders for pipes and ship bearings, and orders from western firms are appearing.

The yard has passed the point of maximum production decline. In recent years the yard lost many good specialists, and around 3,000 workers were discharged. Now this process has stabilized and the number of workers is around 8,000, but good specialists continue to leave since they receive substantially more in commercial structures. It must be said that the situation in western countries is such

that workers with the same skill receive approximately the same no matter where they work. But here workers in commercial banks receive many times more than in production. A certain production upswing has begun, but it would be considerably faster were we to succeed in resolving the question of circulating assets and were inflation to stop. The government is not resolving questions of investments, and commercial banks today are not ready for long-term financing of industry. It must be said that a number of European countries have special banks which work with certain kinds of industry, including shipbuilding. Russia has no such practice for now.

Nevertheless, the Baltic Yard looks confidently to the future. We hope to carry out the yard's renovation rather quickly and to create products that are fully competitive by western yardsticks. Workers constantly arrive at the notion that we should revive the yard ourselves and not place hopes on a kind uncle. If there is help from the state, fine; if there is not, we should cope ourselves. Unfortunately, in recent decades of the USSR's existence, state investments were directed to shipyards not of Russia, but of Ukraine (Kerch, Nikolayev), where more modern technology was created. Our yard has to do this itself, for now without the help of the Russian leadership.

In conclusion I would like to reemphasize that the Baltic Yard now would like to retain at least a portion of state, including defense, orders for many reasons. But this desire also has to be mutual in action, not in words.

CONVERSION

Problems of the Russian Scientific-Technical Complex of Podmoskovye

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Anatoliy Vasilyevich Dolgolaptev completed Moscow Higher Technical School imeni N. E. Bauman. He is a candidate of technical sciences and a specialist in the field of electrophysical methods of the destruction of rocks. Up until 1991 he worked in the Institute of Mining imeni A. A. Skochinskiy. He presently is first deputy head of Moscow Oblast Administration and deputy of the Russian Federation Federal Assembly Federation Council. He directs the development of regional policy for developing the Podmoskovye scientific-technical complex.

Continuing the analysis of problems of conversion of enterprises, scientific research institutes and design bureaus of defense sectors of industry begun in the journal's pages by B. V. Gusev and A. P. Kotov (see VOORUZHENIYE, POLITIKA, KONVERSIYA, No 1, 1993), we would like to draw readers' attention to regional problems of this socioeconomic phenomenon that is new to us.

In studying features of the Podmoskovye scientific-technical complex, we arrived at the conclusion that it is impossible to set up a scientifically substantiated and consequently effective policy for its preservation and development without comprehending and considering the following key points, which also are characteristic of the majority of other regions of Russia:

1. Conversion of the defense complex should be viewed as part of a more general process of fundamental structural changes of the entire scientific-technical complex, including all basic and applied science as well as education.

2. The goal of structural transformations of the scientific-technical complex must be unconditional preservation and development of high science-intensive, competitive technologies, which must become "locomotives" for industry and the agrocomplex in taking our basic sectors to a world technological level, and which must accomplish tasks of their ecologic cleanness, reliability, and resource and energy conservation.

3. Realization of fundamental structural transformations in the region's scientific-technical complex, including conversion programs, is a long-range, costly measure and requires mobilization of all the territory's resources (investment, material and so on). All extrabudgetary sources of investments must be attracted, for which it is necessary to create a favorable legislative and legal environment and provide a system of guarantees.

4. Regional scientific-technical policy will be well-grounded only if it integrally considers federal and regional interests in using both federal and regional resources.

The points set forth serve as a starting point for us and as principles in forming basic directions of regional policy for development of the Moscow Oblast scientific-technical complex, the status and prospects of which largely determine prospects for development of the Oblast as a whole.

In order to realize the determining role of the Podmoskovye scientific-technical complex in future development of the Oblast as a whole, we will cite certain information about this complex.

Moscow Oblast numbers 6.64 million persons or 4.5 percent of Russia's population, and its area is 46,000 km^2 (0.3 percent of Russia's area). The Oblast scientific-technical complex is a very major regional complex of

Russia. It is characterized by the country's highest science-intensiveness of industries and the most advanced technologies. A significant part of the region's scientific-technical complex in the past was oriented on defense and now is in the process of a profound conversion. Approximately half of the Oblast's able-bodied population (around 1.5 million persons) is employed directly or indirectly in the scientific-technical complex. The Oblast has a unique cadre potential: approximately 140 specialists with a higher education per thousand residents.

The following are the main components of the Oblast scientific-technical complex:

- scientific research establishments of the Russian Academy of Sciences (Troitsk, Noginsk and Pushchino science centers, a total of over 40 institutes, their separate subunits, branches, and experimental stations);
- scientific research and design establishments of the Russian Agricultural Academy, their branches, experimental stations, and experimental production farms (40 institutes and experimental stations, 70 cattle breeding and experimental production farms and other scientific installations);
- sectoral scientific research establishments, planning institutes and design bureaus with experimental plants and industries (for example, Protvino and Dubna science centers, Obolenskiy Biological Center, and Institute of Mining imeni A. A. Skochinskiy);
- scientific-production associations, institutes and design bureaus of defense sectors;
- testing establishments (institutes, test areas and centers) conducting experimental development and finishing of equipment models being created: Geodeziya NII [Scientific Research Institute] and NII of Mechanization in the city of Krasnoarmeysk, LII [Flight Research Institute] imeni Gromov and the flight-test and development base of Opyt MMZ in the city of Zhukovskiy, NIIKhimmash [Scientific Research Institute of Chemical Machinebuilding] and NIIKhimstroymash in the city of Sergiyev Posad, NITs [Scientific Research Center] for Test and Development of Motor Vehicle Equipment in the city of Dmitrov, an aircraft systems test range in the city of Belozersk, a railroad test area in the city of Shcherbinka and others.

The defense complex, the largest component of the Oblast scientific-technical complex, is represented by five main sectors:

- missile-space, the largest representatives of which are the cities of Kaliningrad (TsNIIMASh [Central Scientific Research Institute of Machinebuilding], Energiya NPO [Scientific Production Association], IT NPO, Khimmash [Chemical Machinebuilding] Design Bureau, Kompozit NPO, Strela Design Bureau); Khimki (Energomash NPO, NPO imeni Lavochkin, Fakel MKB [Machinebuilding Design Bureau]); Reutov (Machinebuilding NPO); Sergiyev Posad (Central Scientific Research Institute of Special Machinebuilding, Scientific Research Institute of Chemical Machinebuilding, NIIKhimstroymash); Kolomna (Machinebuilding Design Bureau); and Dubna (Raduga MKB);
- aircraft, the largest representatives of which are the cities of Zhukovskiy (TsAGI [Central Aero-Hydrodynamics Institute], Flight Research Institute, EMZ [Experimental Machinebuilding Plant] imeni Myasishchev, Scientific Research Institute of Aircraft Equipment, ZhMPO); Lytkarino (a branch of TsIAM [Central Institute of Aircraft Engine Construction], Soyuz MKB, Zvezda MZ, possibly machinebuilding plant]); Ramenskoye PKB and Helicopter NTK [Scientific-Technical Complex] imeni N. I. Kamov; Lukhovitsy Aircraft Plant; and Solnechnogorsk Machinebuilding Plant;
- electronics, uniting over 20 scientific research institutes and enterprises in the cities of Fryazino (scientific production associations and institutes Istok, Platan, Laminar, Tsiklon-Test, Elektronpribor and Tor); Solnechnogorsk (SEMZ [Solnechnogorsk Experimental Machinebuilding Plant]; Sergiyev Posad (Zvezda Production Association); and Pavlovskiy Posad (Eksiton);
- precision machinebuilding, instrument making and special chemistry, the largest representatives of which are the cities of Klimovsk (TsNIITOChMASh [Central Scientific Research Institute of Precision Machinebuilding], Automatic Lines Design Bureau, Klimovsktekhmash Production Association); Podolsk (Podolsk Machinebuilding Plant and Electrical Machinery Plant); Sergiyev Posad (ZOMZ, Scientific Research Institute of Applied Chemistry, Scientific Research Institute of Elastomer Materials, Scientific Research Institute of Bearings); Zheleznodorozhnyy (NITI [Scientific Research Textile Institute]); Krasnogorsk (KMZ [Krasnogorsk Machinery Plant]); Krasnozavodsk (KKhZ); Balashikha (Kriogenmash Production Association); Roshal (Chemical Combine); Dubna (Machinebuilding Plant, Atoll NPO, Tenzor NPO); Kolomna (Kolomnatekhmash Production Association); Lyubertsy (LNPO [Lyubertsy NPO] Soyuz) and others;
- special metallurgy, enterprises of which produce special grades of steel and alloys for the atomic and aerospace sectors: metallurgical plants in the cities of Elektrostal and Stupino, and the Podolsk Giredmet Production Association.

Around 20 percent of all of Russia's scientific organizations and 13 percent of all scientific workers are concentrated on Oblast territory and 26 percent of the total volume of scientific work is done there. The proportion of scientific work of a basic nature is 23 percent (for Russia as a whole it is less than 9 percent).

A feature of the Oblast scientific-technical complex is that it is concentrated in isolated small cities and settlements (science cities) with 1-3 city-forming enterprises, with the status of the entire social sphere depending on the status of their economy. The Oblast has over 20 such small cities, legislatively laid down in the 1930's through 1970's for creating science-intensive products primarily of a defense direction through a high concentration of scientific-technical potential (there are around 50 for Russia as a

whole). These are the cities of Dzerzhinskiy, Dolgoprudnyy, Dubna, Zheleznodorozhnyy, Zhukovskiy, Kaliningrad, Klimovsk, Protvino, Pushchino, Reutov, Troitsk, Fryazino, Chernogolovka and others. At the present time, when the state order has dropped more than 3-5 times, the Oblast scientific-technical complex concentrated in these science cities and their social infrastructure have been placed on the verge of catastrophe.

At the same time, the Moscow Oblast scientific-technical complex basically supports federal needs and is Russia's national property. As pointed out earlier, our region's scientific-technical potential and high technologies are capable of ensuring Russia's worthy role in the post-industrial world, of being "locomotives" for basic sectors of the national economy and taking them to a world technological level if a set of measures for their preservation and development is realized.

At the same time, the Oblast's future as a region lies in the development of highly intellectual kinds of activity and high science-intensive technologies, since there simply is no alternative to this version of development: other opportunities for applying labor and capital are absent, mineral resources are absent, and the soil is insufficiently fertile to carry on effective agriculture. The situation is such that even if the Oblast lacked a powerful material and human base for intellectual activity and development of high technologies and lacked a developed communications infrastructure, all this would have to be created. We would like to express certain considerations on directions of regional policy of the Moscow Oblast scientific-technical complex.

The colossal creative and material-technical potential concentrated in the Oblast permits it to perform the role of leader in an innovative sphere and become the center of innovative activity in Russia. For these purposes a complete innovation life cycle from RDT&E to industrial production should be accomplished on Oblast territory. The innovative enterprise should become the central element of the Oblast's production structure and the object of greatest support.

Innovative technologies of the Oblast scientific-technical complex should themselves become the main market product (in volume) produced by the Oblast economy, and this market product should have an export orientation. This is explained on the one hand by the high degree of competitiveness of the majority of technologies of the defense complex, and on the other hand by the absence of demand for new technologies, products and services in the domestic market, and this trend obviously will be preserved for another 5-7 years.

To this end, a regional infrastructure of innovative activity should be formed:

- communications equipment;
- information technologies and telecommunications;
- credit-financial sphere;
- share market;
- network of organizations providing services of a special nature: insurance, patenting, advertising, legal and financial consulting, preparation of investment projects and so on;
- techopark structures in components [subyekty] of innovative activity.

Science cities can become centers of scientific-technological innovations.

A comprehensive study, both conceptual as well as detailed, of necessary actions with respect to science cities based on priorities and immediacy was made and went through hearings in the Russian Federation Supreme Soviet.

Drafts of the following legal and economic documents presently are being finalized:

- on formulating regulating sources of Oblast and municipal budgets with respect to outlays for the social infrastructure;
- on taxation of components of innovative activity;
- on giving guarantees and insuring investments in the innovative sphere;
- on export-import policy in the area of science-intensive technologies and special, dual-purpose equipment;
- on protection of intellectual and industrial property.

A large number of organizations and enterprises which perform basic research, where to this day highly qualified specialists work and where there is unique gear and experimental-test benches and complexes, are concentrated in Podmoskovye. To preserve the most valuable organizations, it is envisaged creating state science centers on their basis. In accordance with Russian Federation Presidential Edict No 939 of 22 June 1993 and Russian Federation Government Decree No 1347 of 25 December 1993, their activity should be regulated and fully financed as federal science installations with special forms of state support to their activity.

A number of organizations presently have been formalized in Podmoskovye as state science centers, including the Central Aero-Hydrodynamics Institute in the city of Zhukovskiy, the All-Russian Scientific Research Institute of Physicotechnical and Radiation-Technical Measurements in the settlement of Mendeleyev, the High-Energy Physics Institute in Protvino, the Troitsk Institute of Innovative and Thermonuclear Research, and the State Scientific Research Institute of Microbiology.

Of course, it is impossible to maintain all the region's science organizations from the state budget. The Oblast Administration is performing much work to attract Russian and foreign investors. It must be said that great interest is being shown by commercial circles of Germany, Taiwan, Turkey, Italy, India and other countries. Investments already have begun coming in.

Associations of industrial enterprises and financial structures in financial-industrial groups are a new organizational-economic form, which uses the potential of the Oblast scientific-technical complex and is capable of successfully performing the task of retooling basic sectors of the national economy.

A pilot project of such a regional association presently is being realized by a number of enterprises in the south-eastern part of Moscow Oblast (the cities of Zhukovskiy, Ramenskoye, Lyubertsy, Lytkarino, Reutov and Balashikha).

Many defense complex enterprises are concentrated in Podmoskovye. The process of their conversion has been occurring spontaneously up to now. It must be given a controllable character and be directed toward modernization of basic sectors in which to support the comprehensive introduction of technological achievements of defense sectors of industry within the scope of special state programs.

5. However, that approach is impossible to realize without additional measures for stimulating the process of privatizing enterprises of defense sectors of industry and also without their substantial structural reorganization.

In our view, we have formulated a package of necessary measures, and its legislative formalization would substantially increase the effectiveness of fundamental economic reforms in the defense industry.

In our view, the following would be advisable:

1. With the approval of plans for privatizing enterprises of defense sectors of industry, the Russian Federation State Committee on the Administration of State Property and its territorial agencies should provide for investment competitions (investment tenders) as the main method for selling shares remaining after the closed subscription among enterprise workers, with payment by privatization checks and currency of the Russian Federation in accordance with existing legislation.

2. Establish that if the winner in an investment competition (investment tenders) for the sale of shares of enterprises being privatized is an enterprise of defense sectors of industry, it be granted up to a 30 percent discount on the sale price and a deferred payment for up to one year.

3. With the sale of shares of enterprises indicated in the previous paragraph at investment competitions (investment tenders), permit property funds to take requests from legal persons in whose authorized capital the share of the state, public organizations (associations) and philanthropic and other public funds does not exceed 50 percent, on condition that such legal person is an enterprise of defense sectors of industry.

4. Permit the Russian Federation State Committee for Administration of State Property and its territorial agencies:

- to establish in standard charters restrictions for a period up to three years on alienation of shares of enterprises of defense sectors of industry for shareholders who received them in the form of privatization from Property Funds;
- in plans for privatizing enterprises of defense sectors of industry, to independently establish time periods and the allotment of shares to be sold at check auctions and in investment competitions, and to direct shares amounting to 10 percent of authorized capital to check auctions;
- to introduce amendments to the Charter of an open joint-stock company, established on the basis of an enterprise of defense sectors of industry, reflecting features of the specific enterprise and obligations of the joint-stock company to ensure a regime of secrecy and safekeeping of mobilization stocks and reserves.

5. To permit property funds, when conducting investment tenders, to accept state promissory notes for financing the state defense order as means of payment. Promissory notes are set off toward a portion of the funds being directed to the federal budget, and cannot exceed the amount of this portion. The funds transfer these promissory notes to the Russian Federation Ministry of Finance.

6. To charge the Russian Federation Ministry of Finance to provide for allocating funds from the republic budget for participation financing (at least 50 percent) of social-cultural and communal-everyday facilities remaining on the balance sheet of privatized enterprises and scientific defense organizations.

Using achievements of the defense complex as the basis of dual technologies can play a large role in managing conversion. In June 1994 Russian Federation President B. N. Yeltsin visited the Lyubertsy Soyuz NPO, where missile fuel is produced. A decision was made to set up a Federal Dual Technologies Center there, where missile fuel production technology also will be used for creating aerosol fire extinguishing agents, in pharmacology, and in the manufacture of man-made diamonds and tools from them.

All this will be done without involving budgetary funds. At the 1994 Leipzig Fair we succeeded in interesting the firm of Dynamit-Nobel in fire extinguishing aerosols. Other Russian and foreign firms also are showing great interest in these technologies.

We hope that measures being taken will permit preserving the potential of the Podmoskovye scientific-technical and defense complex. They could be used in creating similar development models for other regions of Russia as well.

Conversion of Military Production: Questions and Problems

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[Article by Georgiy Borisovich Kezling, director of St. Petersburg branch of Central Scientific Research Institute of Economics and Conversion of Military Production, candidate of technical sciences, academician of International Academy of Information Support; photograph of Kezling included]

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He presently is director of the St. Petersburg branch of the Central Scientific Research Institute of Economics and Conversion of Military Production. He is a candidate of technical sciences, an academician of the International Academy of Information Support, and the author of 70 scientific works. He has been decorated with many government awards and with the Academician M. K. Yangel Medal for participation in creating missile-space equipment.

There are two contrasting viewpoints on conversion. One is that conversion is a boon, since the defense complex received a lion's share of the state budget and gave almost nothing to the national economy in return; the other viewpoint is that conversion is a colossal detriment to Russia's industry and the entire national economy as a whole, and in the final account conversion will lead to the collapse of industry and disintegration of scientific and planning organizations, as a result of which our state will turn into a third-rate country supplying raw materials and a cheap labor force to the civilized world.

Let us attempt to examine what is occurring with conversion at the present time. It can be noted right off that both of these viewpoints are incorrect, to put it mildly, and the status with conversion is much more complicated than was assumed in making the decision to conduct it. An analysis of fulfillment of UN recommendations (1981) on development of national conversion plans and progress in their fulfillment in the United States, Great Britain, Germany, Sweden and the PRC showed that these countries view conversion as a normal phenomenon in the dynamics of industrial development under conditions of scientific-technical progress. Despite different methods and ways of conducting conversion in these countries and different problems and assessments which have shown up, the following general conclusions can be drawn:

- conversion permitted forming a strategic scientific-industrial policy of states for 15-25 years;
- formation of the conversion concept in each country occurred on the basis of military doctrine and with consideration of a forecast of the world military-political situation;
- as an element of state policy, conversion should facilitate a stimulation of production of new kinds of products and commodities, minimize the reduction of jobs and not permit a drop in the standard of living for different layers of the population;
- conversion is a lengthy process (at least 10-15 years) which demands constant attention and financial support by the state and an improvement in the mechanism of its conduct with consideration of changing socioeconomic and political factors;
- conversion requires significant outlays and investments, and it is advisable to evaluate its results over the long term with consideration of economic and social results of disarmament and reduction of military expenditures.

And the final conclusion is that in practice no one in the world has yet managed to realize a concept of "rapid conversion," "rapid reforms" or "great leaps."

A conversion of military production in our country was carried out three times: in the postwar period of 1945-1947, the conversion of 1955-1965, and the conversion begun in 1988.

State plans and directives and the timely preparation of decrees, decisions and measures were the basis for restructuring military industry during 1945-1947. Decrees and decisions were fulfilled in the shortest time periods, with a high sense of responsibility, under rigid control, and with well adjusted communications and prompt information.

The preparation of measures for determining the necessary nomenclature of the output of civilian products and consumer goods was an important point in conducting conversion. The national economy was being developed on the basis of five-year plans, and the output of civilian products was planned not only in terms of enterprises and people's commissariats, but also in terms of economic areas and the country as a whole. All this permitted achieving the prewar level of production of civilian products by 1947 and simultaneously solving a number of social problems and preserving the country's defense capability at a sufficient level.

The conversion of 1955-1965 occurred in a period of relaxation of international tension and a significant reduction in the country's Armed Forces. The state of the national economy needed a restructuring of military production to expand the output of civilian products. A distinguishing feature of this period was that along with a reduction in the Armed Forces and an increase in the output of civilian products, there occurred an intensified development of RDT&E in the area of creating the newest kinds of armament and military equipment, radio engineering and electronics. But ministries and departments proved unprepared for the wide output of civilian products, which led to a decline in labor productivity, a reduction in wages and loss of highly skilled cadres. But the conduct of conversion provided positive results in the final account: the nomenclature of civilian products manufactured at defense enterprises increased and its quality rose, the socioeconomic situation improved in the collectives of these enterprises, and a number of pieces of household electronic equipment began to be manufactured only at enterprises of the military-industrial complex.

The conversion of military production begun in 1988 went through several stages. In the initial stage (1988-1989) the Ministry of Machinebuilding for Light and Food Industry and Household Appliances was eliminated, with a portion of the enterprises transferred to the military-industrial complex and with state orders issued to enterprises of defense sectors of industry for manufacturing equipment for the light and food industry. This led to specialization of sectors for manufacturing equipment for processing certain kinds of products, including for milk, meat, textile production and so on. But a number of negative points showed up here, which include the following:

- forced specialization of enterprises and organizations of the military-industrial complex;
- relatively small volumes of state orders (right down to solitary orders);
- isolation of enterprises from end users of the ordered products;
- a large portion of products did not satisfy consumer requirements.

As a result, the expected effect was not achieved in this stage.

The second stage of conversion (1990-1993) involved a search for a mechanism for putting out, instead of military

products, those civilian products which could be sold both in domestic as well as foreign markets. But the absence of a precise state policy and improper economic methods of conducting conversion led to a reduction in production volume and to a significant worsening not only of the economy of the military-industrial complex, but also of the economy of the country as a whole. For example, over the last five years of conversion of military production in St. Petersburg, the overall volume of products manufactured by the city's defense enterprises dropped 38 percent compared with 1988 and the number of persons working at defense enterprises was reduced 28 percent, and a sharp production drop continues up to the present time. This is explained both by a reduction in the volume of Russian Ministry of Defense orders for production of armament and military equipment and by debt in paying for products already manufactured, as well as by a drop of the volume of output of civilian products and consumer goods in 1993 due to a drop in the population's paying capacity. Unfortunately, a preliminary forecast for 1994 indicates a further drop (true, a less significant one) in the volume of products being put out by defense enterprises, nor is an improvement noted in the situation in St. Petersburg scientific research institutes and design bureaus. A similar situation also is observed in other regions and for the country as a whole.

An analysis of the existing management system of enterprises and organizations shows that one of the most substantial shortcomings is the absence of a state mechanism for communicating a decision within established time periods to those responsible for executing it. Decisions made at the state level are communicated to specific performers within prescribed time periods only in 15-20 percent of the cases, around 30-35 percent of decisions are communicated with a considerable delay, and the rest do not get to them at all. An adjusted system of monitoring progress in fulfilling decisions is absent. A similar situation also is observed at a territorial level.

In our view, to emerge from the crisis situation it is necessary to develop and approve the "Comprehensive Fifteen-Year Program for Conversion of Military Production" (henceforth the "Program") at the Government level.

1. It is necessary to envisage in the "Program" assurance of the formation of a plan for enterprises of the military-industrial complex which contains sections for fulfilling the following:

1.1. A state defense order providing for the following:

- conduct of basic and applied RDT&E supporting the creation and development of armament and military equipment and of the scientific-technical and technological base;
- modernization and recycling of armament and military equipment;
- development of dual-purpose equipment and technologies;
- acquisition of set-completing articles and materials;
- work to create, preserve and develop mobilization capacities of enterprises, assurance of unfolding production in a special period, and so on.

1.2. A state order for development, production and delivery of products and commodities for the most important state needs.

1.3. A municipal order for development, production and delivery of products, commodities and services satisfying the interests of the municipal economy, the population and the city as a whole.

1.4. Individual orders for commercial structures and based on results of marketing and other kinds of activity by the enterprise.

2. The "Program" should provide for the following to ensure normal activity of enterprises:

2.1. Development and approval by the Government of legislative-legal documents, which specify the following:

- status of the state ("fiscal") enterprise;
- status of the state defense order for military products supporting realization of military doctrine, and of the state order for the most important civilian products necessary for conduct of state policy;
- status of the municipal (territorial) order for civilian products manufactured for priority satisfaction of requirements and needs of the municipal economy, population, city and economic region;
- creation of systems of preferential federal taxation for the state order and preferential municipal taxation for the municipal order, and preferential granting of credits for those orders;
- creation of a conversion development assistance fund, which should be a state noncommercial organization and should carry out its activity jointly with the Ministry of Economics and the State Committee on the Defense Industry as well as the Fund for Support of Enterprise and Development of Competition. It will be necessary for state and municipal agencies which issue corresponding orders each to transfer 3 percent of the amount of the order to that fund;
- an increase in the advance for performers of work of the state order up to 50 percent of the annual amount of budgetary appropriations for purchase of armament, military equipment and scientific-technical products;
- support of an annual allocation of appropriations of not less than 20-25 percent of the overall volume allocated for defense for financing RDT&E for the development of armament and military equipment.

3. The second section should present the creation of a mechanism for organization and management of this "Program." The Russian Federation State Committee for Defense Sectors of Industry can become the chief organizer for development and subsequent realization of the "Program." Together with the Russian Federation Ministry of Defense, Russian Federation Ministry of Economics and other interested departments, it should support a resolution of the full set of questions by providing regulations for forming the state defense order, for communicating it to the performer and for exercising supervision over the manufacture of articles. Acceptance of a state

order for fulfillment is mandatory for the state ("fiscal") enterprise, and for enterprises with other kinds of ownership, conditions of economic incentive should be created for these enterprises to receive such an order.

4. The third section of the "Program" should reflect specific assignments—what must be manufactured under the state order when and by whom. This section should be formed as a five-year plan with a specific annual target.

Economic development committees of local (territorial) managerial bodies form their own municipal orders for products necessary to satisfy requirements of the municipal economy, population and city as well as the region. The municipal order is accepted by state enterprises as a mandatory nomenclature, and by other enterprises based on their economic interests.

The scheme suggested above for the functioning of industry will permit using the advantages of centralized planning of the manufacture of state products and of the market economy. State planning should be done only in consolidated indicators, i.e., planning in items (units) of end articles, and the entire set-completing portion must be supported by the enterprise manufacturing the end product. Counterpart enterprises for the manufacture of set-completing products must enjoy the very same privileges as the leading manufacturer.

Enterprises (nonstate) of various forms of ownership form their production plans based on economic expediency of fulfilling a particular order. The issue of a state defense order for this group of enterprises must be on a competitive basis. The Goskomoboronprom [State Committee for the Defense Industry] together with administrations of corresponding cities (regions) on whose territory enterprises participating in competitions are located can be the organizer of corresponding competitions. The state order for these enterprises is a stable work volume for a specific period with tax, credit and other privileges and backed up by corresponding state resources.

A municipal order also must be placed by organizing competitions among enterprises wishing to receive this order.

It appears that adopting such a "Comprehensive Program" will permit improving the situation of conversion enterprises considerably, ensuring fulfillment of the state defense order, and stabilizing the economic situation in the defense complex.

FROM ABROAD

Problems of Eliminating Nuclear-Missile Weapons Stationed on Ukrainian Territory

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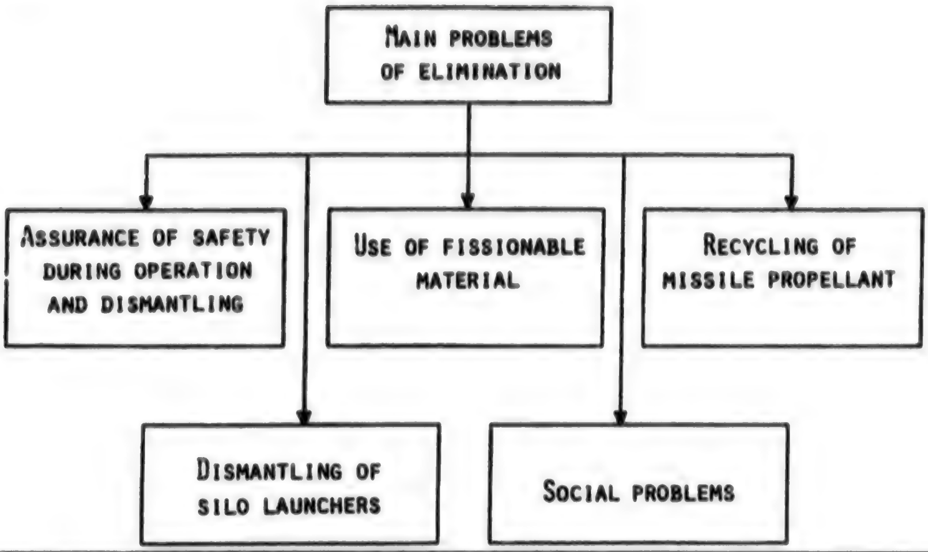
As a result of the USSR's disintegration, 176 missiles equipped with nuclear warheads remained on Ukrainian territory; of these, 130 have liquid-propellant and 46 have solid-propellant boosters of the latest generation. Plutonium and enriched uranium are used as the weapon.

The Ukrainian Supreme Soviet ratified the START I Treaty, in accordance with which Ukraine will be a non-nuclear weapon state after elimination of nuclear-missile weapons. An analysis of work connected with eliminating nuclear-missile weapons stationed on Ukrainian territory showed that a number of very complex scientific-technical and technological questions on dismantling and on recycling elements of the nuclear-missile systems must be resolved to ensure maximum nuclear and ecologic safety.

The operation of strategic weapons under peacetime conditions includes processes of transportation, storage, placement on alert duty, removal therefrom, and recycling. Operating safety in this period is ensured by the missile and warhead design, by the means of transportation, by corresponding structures, by choice of certain work technologies and by organizational measures set forth in corresponding operating documentation. All this provides for the following:

- several levels of protection for preventing an active nuclear explosion of the warhead; the levels only can be removed successively and only under flight conditions (a nuclear explosion does not occur even with the emergency detonation of the missile in flight and impact of the warhead);
- separate transportation of the missile and re-entry vehicle.

Solid propellant missile engines do not detonate with a fall from a height of 10 m onto a concrete foundation. But if damages are received which disable protective devices as a result of emergency situations when the missile with warhead is in a silo launcher or in an arsenal, the explosion of



a solid propellant missile engine is possible. Then the warhead's fissionable materials may spread. The size and intensity of the zone of radioactive contamination are insignificant because of the small mass (several kilograms) of radioactive substance and lesser radioactivity compared with radionuclides which form as a result of an active nuclear explosion or the destruction of an atomic electric power station reactor. The possibility of a nuclear explosion is essentially precluded here. According to specialists' assessments, only when there is an effect on a warhead in an arsenal is there a very small probability that mechanical destruction of the warhead will occur, as a result of which, with chaotic divergence of fissionable substance, is there a possibility of a chance coupling of several bits and attainment of critical mass sufficient for the beginning of a very low yield nuclear reaction. Thus, one can consider that the nuclear safety of strategic weapons in peacetime is sufficiently ensured.

With sabotage actions and also under conditions of military operations employing conventional weapons, mechanical destruction of the warhead and missile structure is possible, with the spread of a small quantity of fissionable material over a limited area. The scale of radioactive contamination here is considerably less than with accidents or with the destruction of installations of atomic electric power stations or other enterprises of the atomic industry in the course of combat operations. Thus, based on the overall yield of long-lived radionuclides and contamination of terrain with cesium-137, the destruction of one nuclear reactor of the Chernobyl Atomic Electric Power Station is equivalent to the explosion of 50-100 warheads, each with a yield of around 1 megaton. The overall area of contamination of Ukrainian territory by plutonium with a density of 0.1 curies/km^2 is 1,459 km^2.

A number of problems arise in fulfilling international agreements on eliminating nuclear-missile weapons (see figure). Let us briefly examine their status as of today.

Questions of nuclear safety during warhead removal must be under the constant monitoring of specialists. We hope for cooperation with Russia and for its assistance in resolving questions of dismantling nuclear warheads. A center is being established by Ukraine for providing scientific methods assistance and for monitoring nuclear safety when dismantling warheads based on the "Kharkov Physicotechnical Institute" National Scientific Center.

Hundreds of tonnes of weapon-grade plutonium are being freed up for the United States and the former USSR as a result of mutual disarmament treaties. The paradox is that destroying it now is more complicated than was turning it out. At the present time there is not a single nuclear reactor in Ukraine which could use plutonium.

A BN-600 fast reactor capable of using plutonium as fuel is in operation at the Beloyarskaya Atomic Electric Power Station (Russia). The use of freed-up uranium in atomic power engineering requires creation of capacities for producing fuel elements.

Ukraine did not have infrastructures which would permit it to service and operate nuclear weapons, and creation of such infrastructures is not envisaged in the near future.

The problem of burying atomic electric power station wastes is especially acute. All of Ukraine's atomic electric power stations produce around 3,000 m^3 of solid wastes per year. On the order of 13,800 m^3 of compacted wastes already have accumulated at four atomic electric power stations (not counting the Chernobyl Atomic Electric Power Station). Around 8 million m^3 of weak-activity and medium-activity wastes have accumulated in the zone of the Chernobyl Atomic Electric Power Station.

Missile propellant being removed from eliminated missiles is on the one hand a valuable material and on the other hand it represents ecologic danger.

The following should be considered to be the main alternative options for recycling missile propellant components in the course of eliminating nuclear weapons on Ukrainian territory:

- sale of fuel reserves to states which are developing technologies for development of outer space for peaceful purposes;
- stockpiling and storing fuel reserves for needs of a complex being created in Ukraine for peaceful development of outer space, and also with consideration of prospects for creating economically justified technologies for their reprocessing;
- use of fuel components in Ukraine's economy with the help of existing technologies;
- creation and introduction of new technologies for reprocessing and using heptyl and amyl products;
- destruction of heptyl and amyl by incineration.

Total destruction of available missile propellant reserves should be regarded as economically inadvisable considering the acute shortage of chemical raw materials in Ukraine.

Maximum permissible concentrations of vapors of liquid missile propellant components are as follows: 0.0001 mg/liter for heptyl, which is close in toxicity to standard chemical agents; and 0.002 mg/liter for amyl. The technology for taking apart and recycling solid propellant boosters presently is absent in CIS countries.

The Ukrainian National Academy of Sciences presently is conducting scientific explorations together with organizations of the Ukrainian Ministry of the Machinebuilding Industry for reprocessing heptyl and using products from the reprocessing.

Preliminary results obtained show that heptyl can be fully bound in complex compounds with a number of metals. Various widely accessible and rather inexpensive carbonyl compounds were tested as reagents for binding heptyl. The end products are finely crystalline, nontoxic powders which can be used in light industry (for producing polymer films and artificial leather), the printing industry, agriculture (herbicides and pesticides), medicine and machinebuilding (manufacture of antirust coatings and lubricants).

Other areas of application of already synthesized products or their analogues also are possible, but this requires further research.

For the most rapid conduct of elimination work envisaged by the Treaty Between the USSR and United States on Reduction of Nuclear-Missile Weapons, Ukraine proposes in the first stage to accommodate reserves of missile propellant components in storage facilities and to organize fuel storage until the moment decisions and technologies for their safe and economically justified recycling are ready.

Procedures for eliminating nuclear-missile systems specified by the START Treaty include elimination of silo launchers first of all. This can be achieved with the dismantling of silo launcher elements to a depth of 8 m or by detonating a design charge in the silo shaft at a depth of 6 m. The latter is simple to realize technically, but then the silo shaft is destroyed and secondary resources essentially are irretrievably lost.

In both cases there is guaranteed preclusion of the possibility of using silo launchers for the direct purpose and START Treaty requirements are fulfilled.

A silo launcher is a powerful fortification made of metal-concrete structures with a steel plate thickness to 40 mm and with a silo shaft made of reinforced metal blocks 1,250 mm thick. According to technology existing up to the present time, the maximum depth to which a silo launcher was taken apart was only to the 5 m mark. The especially sturdy part of the silo launcher structure, the lower strength belt, was not subject to dismantling. Therefore such deep dismantling required a completely new technology.

The Institute of Electric Welding imeni Ye. O. Paton of the Ukrainian National Academy of Sciences developed such a technology, which provides for cutting all metal structures of the silo and breaking up the concrete with the help of an explosion.

The technology has the following advantages compared with others:

1. The effective cutting of metal and breaking up of concrete by explosions permits taking the silo construction apart down to weights of individual parts equal to no more than 10 tonnes, which provides an opportunity to exclude from the technological process the use of scarce, powerful, stationary railway hoisting-crane devices with a lifting capacity of 160-280 tonnes, to decrease the requirement for costly cutting equipment with high consumption of energy resources, and to reduce cutting time.

Based on this technology, it is planned to use self-propelled cranes with a lifting capacity of 25 tonnes.

2. New technology for dismantling equipment from the hardware [armaturnyy] compartment has been developed and tested, permitting the exclusion of work connected with digging a pit and making access routes to the compartment's standard installation opening, by transferring the location of the installation opening to the outside of the compartment (toward the silo shaft).

There also are provisions to open the opening using explosive technology.

3. The technology provides for the possibility of preserving the temporary support of tubing and shell of the hardware compartment, which facilitates further use of the silo depending on specific tasks after fulfilling the START Treaty procedure.

4. The cost of dismantling the main technological systems and of explosive work is 1.4 times less expensive than existing technologies.

5. The time for silo elimination is not over 93 days, while under existing technology it is 121 days.

6. Simultaneously with silo elimination, the technology permits separating concrete from metal and recycling scrap ferrous metal directly at the position. Thanks to this there is a decreased need for transporting the reinforced concrete structures being dismantled to servicing areas for

subsequent parting, which reduces transportation costs by at least two times and increases the amount of recycled metal.

In the course of eliminating nuclear weapons on Ukrainian territory the problem arises of converting structures and support systems of missile launchers into facilities with a scientific and national economic purpose.

Realizing such programs will permit avoiding the destruction of costly installations and the infrastructure of military posts, using missile unit servicing personnel, and saving considerable funds which must be spent for the elimination of strategic installations.

An extremely acute problem of social provisions for the officers and warrant officers servicing nuclear-missile systems arises in connection with the elimination of these systems. In addition, in the initial stage of work it is necessary to resolve the question of using freed-up territories, structures, equipment and other material and technical assets with consideration of regional interests for maximum benefit to the Ukrainian economy.

The "Comprehensive Program for Elimination of Nuclear-missile Weapons Stationed on Ukrainian Territory" presently has been adopted in Ukraine. The program provides for a planned solution of the ecologic, technological and social problems raised.

Thus, fulfilling treaty obligations connected with eliminating nuclear-missile weapons leads to the appearance of a number of very difficult problems. Ukraine is doing much for their rational resolution, but this requires a rather large amount of funds and time.

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